

CLEMSON  
UNIVERSITY

GRADUATE SCHOOL  
ANNOUNCEMENTS

1996-97

S.C.  
LD1055  
.C6  
1996/97



## PURPOSE OF CATALOG

The purpose of this catalog is to provide students with a general description of Clemson University and give detailed information regarding the various colleges and departments within the University and curricula offered by the University. Inasmuch as the educational process necessitates change, the information and educational requirements in this catalog represent a flexible program which may be altered where such alterations are thought to be in the mutual interest of the University and its students.

The provisions of this catalog do not constitute any offer for a contract which may be accepted by students through registration and enrollment in the University. The University reserved the right to change without notice any fee, provision, offering or requirement in this catalog and to determine whether a student has satisfactorily met its requirements for admission or graduation. The University further reserves the right to require a student to withdraw from the University for cause at any time.

Each curriculum (Form GS2) shall be governed by the requirements in effect on the date of enrollment. If a student withdraws from the University and subsequently returns or does not remain continuously enrolled (summers excluded), the requirements in effect at the time of return will govern.

## STUDENT RESPONSIBILITY

All colleges and departments establish certain academic requirements that must be met before a degree is granted. Advisors, department heads and deans are available to help the student understand and arrange to meet these requirements, but the student is responsible for fulfilling them. If, at the end of a student's course of study, the requirements for graduation have not been satisfied, the degree will not be granted. For this reason, it is important for each student to acquaint himself or herself with all academic requirements throughout his or her graduate career and to be responsible for completing all such requirements within prescribed deadlines and time limits.

Except as they apply to undergraduate students only, graduate students are subject to the usual procedures and regulations of the University as listed in the general catalog, *Clemson University Undergraduate Announcements*.

## EQUAL OPPORTUNITY IN PROGRAMS AND ACTIVITIES

Federal laws prohibit discrimination under programs and activities receiving federal financial assistance. The statutes listed below are applicable to Clemson University.

### Title VI of the Civil Rights Act of 1964

"No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."

### Title IX of the Education Amendments of 1972

"No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance."

### Section 504 of the Rehabilitation Act of 1973

"No otherwise qualified handicapped individual in the United States shall, solely by reason of his handicap, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."

Clemson University conducts its programs and activities involving admission and treatment of students, employment, teaching, research and public service in a nondiscriminatory manner as prescribed by federal law and regulation.

Inquiries concerning the above may be addressed to:

President  
Clemson University  
Clemson, SC 29634-5002

or

Director  
Office for Civil Rights  
Department of Education  
Washington, DC 20201



## GRADUATE SCHOOL ANNOUNCEMENTS 1996-97





# CLEMSON UNIVERSITY CALENDAR

## FALL 1996-SPRING 1998

### Fall Semester 1996

August 18-19, S-M	Orientation
August 20-21, Tu-W	Late registration
August 22, Th	Classes begin; late enrollment fee applies
August 28, W	Last day to register or add a class
September 11, W	Last day to order diploma for December graduation
September 18, W	Last day to drop a class or withdraw from the University without a W grade
October 30, W	Last day to drop a class or withdraw from the University without final grades
November 4-5, M-Tu	Fall break
November 6, W	Registration for spring, Maymester and summer terms begins
November 28-29, Th-F	Thanksgiving holiday
December 4-5, W-Th	Classes meet; exams permitted in labs only
December 6, F	Reading Day (no classes; lab exams only)
December 7-13, S-F	Examinations
December 18, Th	Graduation

### Spring Semester 1997

January 5-6, S-M	Orientation
January 6-7, M-Tu	Late registration
January 8, W	Classes begin; late enrollment fee applies
January 14, Tu	Last day to register or add a class
January 28, Tu	Last day to order diploma for May commencement
February 4, Tu	Last day to drop a class or withdraw from the University without a W grade
March 14, F	Last day to drop a class or withdraw from the University without final grades
March 17-21, M-F	Spring break
April 5-12, S-S	Honors and Awards Week
April 7, M	Registration for fall semester begins
April 23-24, W-Th	Classes meet; exams permitted in labs only
April 25, F	Reading Day (no classes; lab exams only)
April 26-May 2, S-F	Examinations
May 7, F	Graduation

### Maymester 1997

May 12, M	Late registration and first day of class
May 13, Tu	Last day to register
May 15, Th	Last day to drop a class or withdraw from the University without a W grade
May 17, S	Classes meet
May 21, W	Last day to drop a class or withdraw from the University without final grades
May 24, S	Classes meet
May 27, Tu	Examinations

### First Summer Session 1997

May 19, M	Late registration
May 20, Tu	Classes begin; late enrollment fee applies
May 21, W	Last day to register or add a class
May 28, W	Last day to drop a class or withdraw from the University without a W grade
June 9, M	Last day to order diploma for August graduation
June 11, W	Last day to drop a class or withdraw from the University without final grades
June 24, Tu	Examinations

### Second Summer Session 1997

June 30-July 1, M-Tu	Orientation
July 1, Tu	Late registration
July 2, W	Classes begin; late enrollment fee applies
July 3, Th	Last day to register or add a class
July 4, F	Holiday
July 11, F	Last day to drop a class or withdraw from the University without a W grade
July 12, S	Classes meet
July 24, Th	Last day to drop a class or withdraw from the University without final grade
August 6, W	Examinations
August 9, F	Graduation

### Fall Semester 1997

August 17-18, Su-M	Orientation
August 18-19, M-Tu	Late registration
August 20, W	Classes begin; late enrollment fee applies
August 26, Tu	Last day to register or add a class
September 9, Tu	Last day to order diploma for December graduation
September 16, Tu	Last day to drop a class or withdraw from the University without a W grade
October 20-21, M-Tu	Fall break
October 27, M	Last day to drop a class or withdraw from the University without final grades
November 3, M	Registration for Spring, Maymester and Summer terms begins
November 27-28, Th-F	Thanksgiving holidays
December 2-3, Tu-W	Classes meet; exams permitted in labs only
December 4, Th	Reading Day (no classes for undergraduates; lab exams only)
December 5-11, F-Th	Examinations
December 16, Tu	Graduation

### Spring Semester 1998

January 4-5, Su-M	Orientation
January 5-6, M-Tu	Late registration
January 7, W	Classes begin; late enrollment fee applies
January 13, Tu	Last day to register or add a class
January 27, Tu	Last day to order diploma for May commencement
February 3, Tu	Last day to drop a class or withdraw from the University without a W grade
March 12, Th	Last day to drop a class or withdraw from the University without final grades
March 16-20, M-F	Spring break
April 4-11, Sa-Sa	Honors and Awards Week
April 6, M	Registration for Fall Semester begins
April 22-23, W-Th	Classes meet; exams permitted in labs only
April 24, F	Reading Day (no classes for undergraduates; lab exams only)
April 25-May 1, Sa-F	Examinations
May 6, W	Commencement

Note: Dates on this calendar were accurate at the time of printing; however, they may change as conditions warrant.



## DEADLINE DATES

For those who expect to receive a graduate degree on:

	December 18, 1996	May 7, 1997	August 9, 1997
<b>Last day for:</b>			
Submission of Form GS2, Graduate Degree Curriculum* †	August 9, 1996	December 19, 1996	May 9, 1997
Submission of Form GS4, Application for Graduation and Diploma Order †	September 11, 1996	January 28, 1997	June 9, 1997
Taking of oral and/or written examination	November 27, 1996	April 18, 1997	July 18, 1997
Review and approval by the Graduate School of completed and signed theses and dissertations. Duplication requires one week.	December 5, 1996	April 25, 1997	July 25, 1997
Submission of duplicated copies of theses and dissertations to the Graduate School Office. Date on Approval Page.	December 12, 1996	May 2, 1997	August 1, 1997

## CHECKLIST ON GRADUATE SCHOOL PROCEDURES

The graduate student should carefully note this checklist as well as the above deadline dates.

1. Select (in consultation with the appropriate department head) a major advisor and advisory committee. (See page 27.)
2. Submit Graduate Degree Curriculum (Form GS2). (See page 27.)
3. Satisfy any prescribed language requirement and comprehensive examination prerequisite for admission to candidacy. (See pages 35-37.)
4. Apply for admission to candidacy for a degree and order diploma (Form GS4) after completing at least half the prescribed course work. (See page 27.)
5. Submit completed thesis (if required) or dissertation to research advisor and arrange for final examination by the advisory committee. (See pages 35-37.)
6. Arrange for review of thesis or dissertation with the Graduate School prior to duplication. (See page 34.)
7. Pay binding fee to the bursar and submit approved copies of thesis or dissertation to the Graduate School. Doctoral candidates pay for abstract publication in *Dissertation Abstracts International* and microfilming of dissertation. (See pages 34.)

The final responsibility for following Graduate School procedures rests with the graduate student. Special problems should be referred to the graduate dean.

\* Although Form GS2 is accepted through the deadline dates listed, students are encouraged to submit this form within the time frame suggested under "Filing of a Graduate Degree Curriculum" in the *Graduate School Announcements*. The filing dates are deadlines for forms carrying all required signatures to be in the Graduate School Office.

†A \$25 late fee will be assessed a student whose form is submitted the day after the deadline, and increases at the rate of \$5 per day thereafter (excluding Saturday, Sunday or University holidays). Payment of fees must be made directly to the Bursar's Office and the form submitted to the Graduate School Office.

## ORGANIZATION OF THIS PUBLICATION

The first 39 pages of the *Graduate School Announcements* describe the University, its academic and administrative officers, its fees and services, and the Graduate School policies and procedures. Beginning on page 41 are the graduate programs and courses offered under the colleges of Agriculture, Forestry and Life Sciences; Architecture, Arts and Humanities; Business and Public Affairs; Engineering and Science; and Health, Education and Human Development. The programs are listed alphabetically within each college.



# CONTENTS

STUDENT RESPONSIBILITY .....	inside front cover
EQUAL OPPORTUNITY IN PROGRAMS AND ACTIVITIES .....	inside front cover
CLEMSON UNIVERSITY CALENDAR .....	2
DEADLINE DATES .....	3
DIRECTORY OF GRADUATE PROGRAM INFORMATION .....	6
CLEMSON UNIVERSITY .....	7
Introduction .....	7
University Visitors Center .....	7
Enrollment Opportunities .....	7
Telecampus .....	7
University Governance and Administration .....	8
The Graduate School .....	9
Research Resources .....	9
South Carolina Agriculture and Forestry Research System .....	10
DCIT Computing Facilities .....	10
Clemson University Libraries .....	11
International Programs and Services .....	11
STUDENT SERVICES .....	12
Career Center .....	12
Food Service .....	13
Health Services .....	13
Housing .....	13
RESIDENCE REQUIREMENTS .....	14
Application for Resident Status .....	14
Domicile Requirements .....	14
Penalties for Willful Misrepresentation .....	14
Resident Tuition and Fees .....	15
GRADUATE EXPENSES .....	19
Academic Expenses .....	19
Related Expenses .....	20
Fiscal Policy .....	20
STUDENT EMPLOYMENT AND FINANCIAL ASSISTANCE .....	21
Graduate Appointments .....	21
Hourly Employment .....	23
Loans .....	23
Eligibility for Loans .....	23
Academic Common Market Program .....	23
Special Employment Restrictions .....	23
ADMISSION PROCEDURES AND REQUIREMENTS .....	23
Procedures .....	23
Academic Requirements .....	24
Medical Requirements .....	25
Admission Classifications .....	25
Enrollment in Graduate Courses .....	26
GENERAL GRADUATE SCHOOL REGULATIONS .....	26
Procedures to Follow in Pursuing a Degree .....	26
Academic Regulations .....	27
Academic Research .....	31
DEGREE REQUIREMENTS .....	35
Master's Degree .....	35
Specialist in Education Degree .....	36
Doctor of Philosophy Degree .....	36
Doctor of Education Degree .....	38

GRADUATE PROGRAMS AND COURSE OFFERINGS .....	38
Special Courses .....	38
Explanation of Course Listings .....	38
Course Prefixes .....	38

## COLLEGE OF AGRICULTURE, FORESTRY AND LIFE SCIENCES

SCHOOL OF ANIMAL, BIOMEDICAL AND BIOLOGICAL SCIENCES .....	42
Animal and Food Industries .....	42
Animal, Dairy and Veterinary Sciences .....	42
Animal Physiology .....	43
Biochemistry .....	45
Biological Sciences .....	46
Biology .....	47
Botany .....	47
Genetics .....	48
Microbiology .....	49
Nutrition .....	50
Poultry Science .....	51
Zoology .....	52

SCHOOL OF PLANT, STATISTICAL AND ECOLOGICAL SCIENCES .....	53
Agronomy .....	53
Entomology .....	54
Experimental Statistics .....	55
Horticulture .....	56
Plant Pathology .....	57
Plant Physiology .....	58

SCHOOL OF NATURAL AND RECREATIONAL RESOURCES .....	59
Aquaculture, Fisheries and Wildlife Biology .....	59
Forest Resources .....	60

SCHOOL OF APPLIED SCIENCE AND AGRIBUSINESS .....	62
Agricultural and Applied Economics .....	62
Agricultural Education .....	65
Agricultural Engineering .....	66
Agricultural Mechanization .....	66
Agriculture .....	66
Applied Economics .....	67
Environmental Toxicology .....	67
Food Science .....	69
Food Technology .....	70

## COLLEGE OF ARCHITECTURE, ARTS AND HUMANITIES

SCHOOL OF DESIGN AND BUILDING .....	72
Architecture .....	72
City and Regional Planning .....	74
Construction Science and Management .....	76

SCHOOL OF THE ARTS .....	78
Performing Arts .....	78
Visual Arts .....	78

SCHOOL OF THE HUMANITIES .....	79
English .....	79
History .....	82
Languages .....	84
Philosophy and Religion .....	84
Professional Communication .....	84



**COLLEGE OF BUSINESS AND PUBLIC AFFAIRS**

SCHOOL OF ACCOUNTANCY AND LEGAL STUDIES .....	86
Accounting .....	86
SCHOOL OF BUSINESS AND LEADERSHIP .....	87
Applied Economics .....	87
Business Administration .....	87
Economics .....	91
Finance .....	94
Graphic Communications .....	94
Industrial Management .....	94
Management Science .....	97
Marketing .....	98
SCHOOL OF SOCIAL SCIENCE .....	98
Applied Sociology .....	98
Political Science .....	100
Psychology .....	102

**COLLEGE OF ENGINEERING AND SCIENCE****SCHOOL OF CHEMICAL AND MATERIALS**

ENGINEERING .....	106
Bioengineering .....	106
Ceramic Engineering .....	108
Chemical Engineering .....	109
Materials Science and Engineering .....	111

SCHOOL OF THE ENVIRONMENT .....	112
Environmental Science and Policy .....	112
Environmental Systems Engineering .....	113
Environmental Toxicology .....	115
Hydrogeology .....	115

**SCHOOL OF MECHANICAL AND INDUSTRIAL**

ENGINEERING .....	117
Engineering Graphics .....	117
Engineering Mechanics .....	117
Industrial Engineering .....	118
Mechanical Engineering .....	120

**SCHOOL OF TEXTILES, FIBER AND POLYMER**

SCIENCE .....	123
Textile and Polymer Science .....	123
Textile Chemistry .....	123
Textile Science .....	124

Agricultural Engineering .....	125
Chemistry .....	126
Civil Engineering .....	128
Computer Engineering .....	131
Computer Science .....	133
Electrical Engineering .....	136
Management Science .....	140
Mathematical Sciences .....	140
Physics .....	146

**COLLEGE OF HEALTH, EDUCATION AND HUMAN DEVELOPMENT**

Counseling and Educational Leadership .....	150
Curriculum and Instruction .....	155
Foundations and Special Education .....	160
Parks, Recreation and Tourism Management .....	162
Public Health .....	164
Technology and Human Resource Development .....	165
Industrial Education .....	167
Vocational/Technical Education .....	168

SCHOOL OF NURSING .....	169
-------------------------	-----

INDEX .....	173
-------------	-----

DIRECTORY FOR CORRESPONDENCE .....	inside back cover
------------------------------------	-------------------



# DIRECTORY OF GRADUATE PROGRAM INFORMATION

	Ph.D.	Ed.D.	M.S.	M.A.	Professional Master's	Entrance Examination
<b>College of Agriculture, Forestry and Life Sciences</b>						
Agricultural and Applied Economics			■			1
Agricultural Education					■	
Agricultural Engineering (i)	■		■		■	1
Agriculture					■	
Agronomy	■		■			1
Animal and Food Industries (i)			■			1
Animal, Dairy and Veterinary Sciences						
Food Science						
Poultry Science						
Animal Physiology (i)	■		■			1
Applied Economics (i)	■					1
Aquaculture, Fisheries and Wildlife Biology	■		■			1
Biochemistry	■		■			1
Botany			■			1
Entomology	■		■			1
Environmental Toxicology (i)	■		■			1
Food Technology (i)	■					1
Forest Resources	■		■		■	1
Genetics (i)	■		■			1
Horticulture			■			1
Microbiology	■		■			1
Nutrition (i)	■		■			1
Plant Pathology	■		■			1
Plant Physiology (i)	■					1
Zoology	■		■			1
<b>College of Architecture, Arts and Humanities</b>						
Architecture			■		■	1
City and Regional Planning					■	1
Construction Science and Management					■	1
English				■		1
History				■		1
Professional Communication				■		1
Visual Arts					■	
<b>College of Business and Public Affairs</b>						
Accounting					■	2
Applied Economics (i)	■					1
Applied Psychology			■			1
Applied Sociology			■			1
Business Administration					■	2
Economics				■		1
Industrial Management	■		■			1 or 2
Industrial/Organizational Psychology	■					1
Management Science (i)	■					1
Public Administration					■	1

	Ph.D.	Ed.D.	M.S.	M.A.	Professional Master's	Entrance Examination
<b>College of Engineering and Science</b>						
Agricultural Engineering (i)	■		■		■	1
Bioengineering	■		■			1
Ceramic Engineering	■		■		■	1
Chemical Engineering	■		■		■	1
Chemistry	■		■			1
Civil Engineering	■		■		■	1
Computer Engineering	■		■			1
Computer Science	■		■			1
Electrical Engineering	■		■		■	1
Engineering Mechanics	■		■			1
Environmental Systems Engineering	■		■		■	1
Environmental Toxicology (i)	■		■			1
Hydrogeology			■			1
Industrial Engineering	■		■			1
Management Science	■					1
Materials Science and Engineering (i)	■		■			1
Mathematical Sciences	■		■			1
Mechanical Engineering	■		■		■	1
Physics	■		■			1
Textile and Polymer Science	■					1
Textile Chemistry			■			1
Textile Science			■			1
<b>College of Health, Education and Human Development</b>						
Administration and Supervision					■	1 or 3
Counseling and Guidance Services					■	
Curriculum and Instruction	■					1
Educational Leadership	■					1
Elementary Education					■	1
Health Administration					■	1 or 2
Human Resource Development					■	
Industrial Education					■	
Nursing			■		1	
Parks, Recreation and Tourism Management	■		■		■	1
Reading					■	
Secondary Education					■	
Special Education					■	
Vocational/Technical Education		■				1

(i) = interdisciplinary program

1 = GRE  
2 = GMAT  
3 = MAT



# CLEMSON UNIVERSITY

## Introduction

Clemson University was founded in 1889 when the General Assembly accepted the terms of the will of Thomas Green Clemson, conveying land and other property to the state for the purpose of establishing a technical and scientific institution. The college opened its doors in 1893 as Clemson Agricultural College, a land-grant institution and military school. It has evolved to its present status as a university emphasizing the sciences and technology.

Clemson was initially an all-male military school until 1955 when women were admitted as residential students. The Graduate School was formally organized in 1947. In 1964 the college was renamed Clemson University, a formal recognition of the school's expanded academic offerings and research pursuits.

Clemson University is a land-grant South Carolina institution under the terms of the Morrill Act of 1862. It serves the state, the nation and the international community through teaching, research and public service activities. Clemson University is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools to award the bachelor's, master's, specialist and doctoral degrees.

The general mission of the University was broadened with the passage of the Hatch Act of 1887, with responsibility for the S.C. Agricultural and Forestry Research System; the Smith-Lever Act of 1914, for operation of the Cooperative Extension Service; and the National Sea Grant Act of 1966. Agricultural research is conducted not only on campus, but at four substations. Regulatory programs provide technical assistance, continuing education, technology transfer and extension activities.

In accordance with the conditions set forth in the will of Thomas Green Clemson and the Act of Acceptance by the General Assembly, Clemson University is governed by a Board of Trustees consisting of 13 members. Of these, six are elected by the General Assembly and seven are life members who elect their own successors.

Clemson University is organized into five colleges: Agriculture, Forestry and Life Sciences; Architecture, Arts and Humanities; Business and Public Affairs; Engineering and Science; and Health, Education and Human Development. Programs leading to baccalaureate degrees in 74 fields of study and 112 graduate programs in 71 areas of study are offered through all five colleges. Doctoral programs currently are authorized in 38 specialties. Research is an indispensable part of most postbaccalaureate education, and Clemson provides research opportunities in all fields in which graduate instruction is offered. The institution's mandate in agriculture and natural resources, architecture, engineering, textiles, basic sciences and technologies is extended to address the state's cultural and economic needs through the health sciences, business, education and the humanities.

The fulfillment of Clemson's mission rests with its faculty, who individually, collectively and in cooperation with all University personnel gather, interpret and disseminate knowledge; generate new knowledge independently and in conjunction with colleagues and students; stimulate creative thought and expression; foster speculative and critical thought; groom leaders; initiate progressive change; prepare students to cope with the world as it is, contribute to developing a better world and appreciate the interconnectedness of modern life; and advance the common good by anticipating and devising new solutions for intellectual, scientific, social and technical problems.

As a steward to taxpayers, alumni, donors and students, Clemson University will husband its resources; engage in strategic planning; implement, direct and review authorized programs, modifying goals and operations as deemed necessary; and assess student, faculty and administrative performance regularly and in accordance with norms upheld by both the University's evaluative procedures and those of appropriate professional societies.

The 1,400-acre campus, on the former plantation of John C. Calhoun, is located on the shores of Lake Hartwell in the northwestern part of South Carolina. The 17,000 acres of University farms and woodlands surrounding the campus and an additional 12,390 acres throughout the state are devoted to research. The University also owns overseas property used for teaching and research in Genoa, Italy, at the Charles E. Daniel Center for Building Research and Urban Studies; and on the Caribbean Island of Dominica at the Archbold Tropical Research Center. Clemson is approximately two and one-half hours from both Atlanta, Georgia, and Charlotte, North Carolina.

## University Visitors Center

The University Visitors Center is located in 103 Tillman Hall. Walking tours are provided by the University Guide Service to answer questions and to acquaint visitors with the Clemson campus. Tours last approximately one hour and are preceded by a 10-minute videotape highlighting Clemson University. Thirty-minute cassette self-guided tours also are available.

The center is open Monday through Friday from 8 a.m. to 5 p.m. From February through November the center also is open on weekends. The office is closed for selected University holidays.

For additional information and to verify tour times, call the Visitors Center at (864) 656-4789.

## Enrollment Opportunities

### On-campus

Total enrollment for the fall semester of 1995 was 16,327. Of this number, 3,866 were graduate students. Approximately 1,890 were classified as full-time graduate students and 1,980 as part-time students. The number of male graduate students was 1,920, and 1,950 were female students. Most degree programs offered by the University are available on campus.

### Off-campus

By virtue of its land-grant mission and at the direction of the state Legislature and/or the South Carolina Commission on Higher Education, Clemson University serves the entire state in certain academic disciplines such as agriculture, architecture, industrial education and others. Courses in these disciplines are offered at various off-campus locations across the state. In addition, the University serves South Carolina by offering some master's degree programs at evening off-campus centers.

Master of Engineering (Civil Engineering)	Charleston
Master of Science (Civil Engineering)	Charleston
Master of Professional Accountancy	Greenville
Master of Business Administration	Greenville
Master of Education (various majors)	Greenville
Master of Health Administration (with MUSC)	Greenville
Master of Human Resource Development	Greenville
Master of Industrial Education	Greenville
Specialist in Education	
(Educational Administration)	Greenville
Master of Science in Nursing	Greenville
Master of Public Administration (with USC)	Greenville
Master of Business Administration	Greenwood
Master of Education (various majors)	Greenwood

For complete details, please refer to the individual college or department descriptions in the Graduate Course Offerings.

## Telecampus

The University Telecampus program coordinates the development and delivery of graduate-credit courses through electronic media. This service is provided to increase the educational opportunities of adults who want professional development or continuing education courses but cannot attend classes on the main campus on a regular basis or during hours that conflict with work.



schedules. Through a digital satellite television network of South Carolina ETV, classes are broadcast live from the Clemson campus to viewing sites in Aiken, Beaufort, Charleston, Columbia, Florence, Greenville, Greenwood, Orangeburg and Rock Hill. A two-way audio linkage via telephone is provided so that students at remote sites may interact with the instructor and students in the Clemson classroom studio.

Information on courses and registration is available at the Telecampus Office, E-205 Martin Hall, Clemson, SC 29634-5121; or by calling 1-800-922-8316 (within South Carolina), 1-800-332-6406 (outside South Carolina) or (864) 656-4227 in the local area.

### ***University Governance and Administration***

The University is governed by a board of 13 members, six selected by the state Legislature and seven self-perpetuating life members, in accord with the will of Thomas G. Clemson. The Board of Trustees is primarily responsible for adopting the basic long-range objectives of the University and the basic policies for achieving them; providing policy instruction for long-range planning; adopting the statutes of the University; electing the president of the University; employing the secretary of the board; maintaining ownership of University assets; and overseeing the evaluation of the University.

The president is the chief executive officer of the University, giving leadership to all phases of University planning; coordinating the operations of all units of the University; carrying out major University public relations functions; evaluating the results of University plans; and appointing personnel who report to the president. The day-to-day operations of the University are administered by the president and executive officers for administration and advancement; agriculture, natural resources and research; student affairs.

The provost and vice president for academic affairs is the chief academic officer of the University. The provost is responsible directly to the president for all academic matters and has administrative jurisdiction over teaching and computing services. Vice provosts assist in administering and performing duties in coordinating graduate and undergraduate curricula; supervising computer information services, the libraries, scholarship and award programs; and other duties assigned by the provost.

Academic deans are the chief administrative officers of their individual colleges and report directly to the provost. They provide leadership in formulating and carrying out educational policy, review and make recommendations on personnel matters, and carry out and administer the academic and financial affairs of their colleges.

The dean of the Graduate School coordinates all graduate programs and advises the provost on policies and regulations pertaining to graduate study. Matters concerning graduate admissions policies, graduate student programs and the granting of graduate degrees are coordinated through this office. The dean chairs the Graduate Curriculum Committee and the Commission on Graduate Studies.

### **Board of Trustees**

Lawrence M. Gressette, Jr., Chairman	Columbia, S.C.
Allen P. Wood, Vice Chairman	Florence, S.C.
Bill L. Amick, Jr.	Batesburg, S.C.
Louis P. Batson, Jr.	Greenville, S.C.
J.J. Britton	Sumter, S.C.
Leon J. Hendrix, Jr.	New York, N.Y.
H. Douglas Kingsmore	Aiken, S.C.
Louis B. Lynn	Columbia, S.C.
Patricia H. McAbee	McCormick, S.C.
Leslie G. McCraw	Greenville, S.C.
Thomas B. McTeer, Jr.	Columbia, S.C.
William C. Smith, Jr.	Columbia, S.C.
Joseph D. Swann	Greenville, S.C.

### **Executive Officers and Deans**

Constantine W. Curris, Ed.D.	President
Steffen H. Rogers, Ph.D.	Provost and Vice President for Academic Affairs
John Kelly, Ph.D.	Interim Vice President for Agriculture, Natural Resources and Research
Gary A. Ransdell, Ed.D.	Vice President for Administration and Advancement
Almeda R. Jacks, M.Ed.	Vice President for Student Affairs
Manning N. Lomax, B.S.	Executive Secretary to the Board of Trustees
Benjamin W. Anderson, J.D.	University Legal Counsel
Frank Mauldin, M.Ed.	Director of Access and Equity
Wade A. Green	Director of the Office of Public Affairs, Columbia
DeWitt B. Stone, Jr., Ph.D.	Assistant Vice President for Academic Affairs
Jerome V. Reel, Ph.D.	Senior Vice Provost and Dean of Undergraduate Studies
Christopher J. Duckenfield, Ph.D.	Vice Provost for Computing and Information Technology
Jerry A. Whitmire, M.In.Ed.	Associate Vice Provost for Academic Administration
William B. Wehrenberg, Ph.D.	Dean, College of Agriculture, Forestry and Life Sciences
James F. Barker, M. Arch.	Dean, College of Architecture, Arts and Humanities
Jerry E. Trapnell, Ph.D.	Dean, College of Business and Public Affairs
Thomas M. Keinath, Ph.D.	Dean, College of Engineering and Science
Harold E. Cheatham, Ph.D.	Dean, College of Health, Education and Human Development
Joseph F. Boykin, M.S.	Dean of the Libraries

### **Graduate School Administration**

Farrell B. Brown, Ph.D.	Interim Dean of the Graduate School
Frankie O. Felder, Ed.D.	Associate Dean of the Graduate School
Mark A. McKnew, Ph.D.	Assistant Dean of the Graduate School
Louis D. Bregger, M.A.	Acting Director, Office of International Programs and Services



## The Graduate School

The Graduate School formulates policies and standards and unifies administrative procedures concerning all graduate work at Clemson University. This includes graduate admission policies, graduate programs and the granting of degrees.

The aims of the graduate programs at Clemson are to provide comprehensive education in special fields, to offer instruction in the methods of independent investigation, and to foster the spirit of research scholarship. Graduate study is much more than a continuation of undergraduate work. Its true spirit is one of inquiry and the desire to add to human knowledge. Graduate study therefore should be contemplated only by students who have already demonstrated in their undergraduate programs unusual intellectual attainments and the power of independent thought and investigation.

### Graduate Curriculum Committee

The Graduate Curriculum Committee acts for the faculty in reviewing all proposals for curricular changes and recommends such changes to the provost. It is comprised of a nonvoting chairperson from the provost's staff, plus the chairpersons of the graduate curriculum committees of the academic colleges. The committee is guided by all applicable University rules and regulations and by the policies established by the Academic Council.

The provost and vice president for academic affairs takes the recommendations of the Graduate Curriculum Committee to the Council of Academic Deans for its scrutiny and advice. The provost and vice president for academic affairs then transmits his or her recommendations to the president for final approval and informs the Academic Council, in summary form, of those curricular changes the president has approved.

Graduate students and faculty who are not members of the Graduate Curriculum Committee are free to attend its meetings.

### Graduate Student Government

The mission of the Graduate Student Government (GSG) is to represent the interests of all graduate students at Clemson University in four vital areas of focus. These are:

- **Communication** — to act as the liaison between the University and graduate students with an emphasis on honest and open communication;
- **Collaboration** — to promote the efforts of graduate students and the University into one united mission of making the Clemson experience one of quality education and reward;
- **Development** — to provide participatory learning experience that allows for the enhancement of graduate students' academic, civic, social and professional development; and
- **Involvement** — to encourage graduate student participation in the University process through GSG and beyond.

The GSG is composed of all graduate students at Clemson University. The GSG Senate consists of two representatives from each academic department. The GSG Executive Board consists of the president, vice president, secretary, treasurer and chairs of the GSG committees. In addition, there are board seats for the executive assistant, the news editor and the assistant news editor.

The GSG elects representatives to various University boards, commissions, committees or councils that solicit graduate student opinions.

## Research Resources

### Sponsored Programs Office

The Sponsored Programs Office coordinates these activities:

- sponsored research;
- educational services;
- public service proposals to outside agencies;

- patent disclosures, applications and negotiations of licensing agreements;
- facility security clearance.

Information and assistance are available on applications for research support from federal and state agencies, industrial organizations, foundations and institutes, as well as fellowships of interest to the faculty.

The director of sponsored programs reports to the vice president for agriculture, natural resources and research, providing advice on University research activities and administrative support for the internal funding of annual faculty research grants and awards.

*Oak Ridge Associated Universities.* Since 1952, students and faculty of Clemson University have benefited from membership in Oak Ridge Associated Universities (ORAU), a consortium of colleges and universities and a management and operating contractor for the U.S. Department of Energy (DOE) located in Oak Ridge, Tennessee. ORAU works with its member institutions to help students and faculty gain access to federal research facilities throughout the country; to keep members informed about opportunities for fellowship, scholarship and research appointments; and to organize research alliances among members.

Through the Oak Ridge Institute for Science and Education, the DOE facility that ORAU manages, undergraduates, graduates, postgraduates, as well as faculty enjoy access to a multitude of opportunities for study and research. Students can participate in programs covering a wide variety of disciplines, including business, earth sciences, epidemiology, engineering, physics, pharmacology, ocean sciences, biomedical sciences, nuclear chemistry and mathematics. Appointment and program length range from one month to four years. Many of these programs are especially designed to increase the numbers of underrepresented minority students pursuing degrees in science- and engineering-related disciplines. A comprehensive listing of these programs and other opportunities, their disciplines, and details on location and benefits can be found in the *Resource Guide* and the *Minority Research and Education Programs* brochure, which are available by calling the contacts below.

ORAU's office for University, Industry and Government Alliances (UIGA) seeks opportunities for collaborative research and development alliances among ORAU members, private industry and major federal facilities. Current alliances include the Southern Association for High Energy Research, the Bioelectromagnetics Research Consortium, High Performance Computing, Bioprocessing, Pan American Association for Physics, Materials Science Forum, and international initiatives in support of the New Independent States in Central and Eastern Europe. Other UIGA activities include the sponsorship of conferences and workshops, the Visiting Scholars program and the Junior Faculty Enhancement Awards. A copy of *Especially for Members*, which details UIGA's programs, is available from the contacts below.

For more information about ORAU and its programs, contact James R. Fischer at (864) 656-3140.

### Research Facilities

*Electron Microscope Facility.* The Electron Microscope Facility is equipped with two transmission electron microscopes, one with EDX capabilities; three scanning electron microscopes, one with EDX, backscatter and voltage contrast capabilities and a JOEL 848 SEM with a six-inch stage capacity; an Auger microprobe with a secondary ion mass spectrometer; an atomic force microscope; a virtual reality work station; and an XRF. The facility is equipped to prepare biological as well as thin films. Secondary equipment includes microtomes, sputter coaters and a dual ion milling machine. Preparation areas for negatives and photographic printing are housed there as well. The laboratory, one of the most outstanding in the Southeast, is located on the ground floor of Jordan Hall.



**Department of Experimental Statistics.** The Department of Experimental Statistics provides a statistical consulting service to faculty, staff and graduate students. Advice and assistance are provided in the design, analysis and interpretation of research. Entry and computer analysis of data are available. Collaborative relationships should be established in the planning stage of research projects.

**Electronic and Photographic Services.** The Department of Electronic and Photographic Services (Communications Center) produces professional-quality video and audio tapes, multi-image presentations, and still and motion picture photography. Various types of projectors, screens, and audio and video recorder/players are available for loan. The unit can produce and receive state and nationwide audio or video teleconferences.

### ***South Carolina Agriculture and Forestry Research System***

Since 1886, researchers at the South Carolina Agriculture and Forestry Research System (SCAFRS) have been addressing the problems of agriculture, agribusiness and the physical and social environment. In addition to the major activities of SCAFRS in the schools and colleges on the Clemson University campus, research facilities are located in Blackville, Florence, Charleston and Columbia.

The mission of SCAFRS is to develop knowledge through research that will provide the information that South Carolina citizens need to make intelligent decisions on matters concerning agriculture, natural resources and the environment. Scientists cooperate with researchers in other states and throughout the world to create better standards of living for South Carolina's citizens through enhancing their use of natural resources. Over the years, scientists have worked in food development and improvement, farming techniques and packaging of biological materials. They continue to work in the new scientific areas of genetic engineering and computer information technology.

SCAFRS has an annual budget exceeding \$23 million, which supports the efforts of more than 100 research faculty FTEs and more than 200 support personnel. Graduate students in several colleges use SCAFRS facilities in their research and educational programs.

### ***DCIT Computing Facilities***

The Division of Computing and Information Technology (DCIT) supports graduate student course work and research through a network of on-campus computers, computer labs, access to the Internet and the World Wide Web (WWW), training and Help Desk facilities. The network includes an IBM compatible mainframe computer running the MVS/ESA operating system and a DEC 3000-500 computer running Digital UNIX. There is also an extensive Novell Netware network connecting desktop computers in offices and computer labs across campus.

DCIT maintains computer labs containing a variety of workstations, microcomputers and peripheral equipment in Martin, Daniel, Brackett, McAdams and Sirrine halls; Cooper Library and Poole Computer Center. Among these, the facilities in Daniel, Martin and McAdams halls contain large laboratories of microcomputers. Dial-up service is available through MCI for a modest charge. Call 1-800-821-5637 for more information.

The campus network, which connects all major buildings and computers on campus, is continually upgraded to keep up with increasing demand for network and Internet access. Workstations and other peripheral equipment attached to this network allow interactive access to all Clemson University systems.

The University is connected to the Internet, a global network of networks which supports electronic mail as well as remote login and file transfer. Internet and WWW access is available on most DCIT-supported platforms. This allows access to a world of on-line information to view and/or print from individual workstations.

There are many information servers on campus that provide access to University, departmental and collegiate information. The Clemson University home page (<http://www.clemson.edu/>) provides access to student information which includes undergraduate admissions, financial aid, graduate admissions, graduate catalog, housing and student organizations. From the DCIT home page (<http://www.cts.clemson.edu/>) access is provided to DCIT-produced documentation, schedules for computer training, schedules for computing labs and other information. The academic colleges home page, available from the Clemson University home page, provides information pertinent to each college.

Each student is assigned a unique computer user ID to use while enrolled at Clemson. A wide range of computing services, including electronic mail, on-line class registration and on-line housing sign-up require this computer user ID.

DCIT offers free computer training for students; call Student Training at (864) 656-0971 or e-mail [trainer@clemson.edu](mailto:trainer@clemson.edu). Consulting and Technical Services (CTS) maintains a Help Desk to assist users with computer-related questions and/or problems. Handout materials can be obtained free of charge at the Help Desk, or documentation can be printed using the WWW.

The administrative offices of the DCIT are located in the Information Technology Center (ITC) at the Clemson Research Park. Consulting and Technical Services and the Help Desk are located in the basement of Poole Agricultural Center.

Except for adjustments in scheduling during holiday periods, Poole Computer Center is open Monday-Thursday, 7:45 a.m.-10:00 p.m. and Friday, 7:45 a.m.-4:30 p.m. Among the remote facilities, hours for Sirrine, McAdams, Daniel and Martin halls are similar to those for Poole. Library workstations are available whenever the library is open. Current schedules for all facilities are available on the WWW from the Help Desk on DCIT's home page.

### ***Policy on Misuse of Computing Resources***

Use of University computing resources, including network facilities and account numbers; interactive terminals; data storage media; other peripherals; local, state, national and international computer networks; microcomputer systems and software for computing activities other than those authorized by the University is strictly prohibited. If the need for other uses develops, the appropriate authorization must be obtained in advance. Use of such resources other than as authorized by the University is regarded as a criminal act in the nature of theft and will require restitution for any theft of computing resources and for any cost incurred by the University due to such misuse.

Unauthorized duplication or alteration of software licensed by the University is strictly prohibited. Clemson University forbids the unauthorized reproduction of computer software or the use of illegally obtained software. Using University equipment to make illegal copies of software is prohibited. Software used at the University may be used only in accordance with the manufacturer's license agreement. Users are responsible for being aware of the licensing restrictions for the software they, or individuals in any unit for which they are responsible, use on any University computer or computer system or on any privately owned computer housed in University facilities.

According to both South Carolina and federal law, it is illegal to reproduce copyrighted software without permission. In any investigation of misuse of computing resources, the University reserves the right to inspect, without notice, the contents of computer files, regardless of storage medium, the contents of electronic mailboxes and computer conferencing systems, and system output, such as computer printout.



## Clemson University Libraries

Current resources and facilities of the Clemson University Libraries make it one of the most important research institutions in the Southeast. Today, the libraries have a collection of more than 11,000 serial titles and 1,500,000 volumes and volume equivalents. Outstanding collections of journals, books, government documents and primary research materials have been developed in many areas, especially agriculture, natural and physical sciences, economics and technology. In the social sciences, particularly strong manuscript collections have been developed around the papers of Vice President John C. Calhoun, U.S. Supreme Court Justice James F. Byrnes, U.S. Senator Strom Thurmond and S.C. Senator Edgar A. Brown. These and other resources are drawn on by scholars from all over the United States, Japan and Europe.

Extensive use of the collection is made by borrowers from many parts of the Southeast through modern, efficient techniques. The libraries have an on-line catalog, LUIS (Library User Information System), which permits access by any terminal tied to the University's mainframe computer and by remote dial-up access. DORIS (Document On-line Retrieval Information Systems) provides access to periodical literature by electronic data bases housed on the University's mainframe. DORIS currently houses nine bibliographic data bases and seven locally created full-text data bases. EDDIE (E-Mail Document Delivery and Information Service) permits faculty and remote users to check out materials via electronic mail, allows others to request interlibrary loans, books and journals to be purchased, as well as to submit reference questions electronically and make suggestions about the libraries. In addition, the Robert M. Cooper Library is linked electronically by OCLC, Inc., to more than 11,000 other libraries around the world for cataloging and interlibrary loan services. The Do-It-Yourself Searching Service is available at night and on weekends to access other bibliographic data bases.

The libraries are primarily used by Clemson University students, faculty and staff engaged in the instructional, research and service efforts of the institution. The resources also are available to, and frequently used by, other citizens of the state under liberal use policies. Other individuals have access to the libraries under special arrangements through the public service staff of the Cooper Library.

The main library (Cooper) consists of six floors that occupy 145,000 square feet of usable floor space. Almost 70,000 linear feet of shelving provide space for 1.25 to 1.5 million items. Seating space accommodates about 1,300 readers.

In addition to the Cooper Library, a major branch is operated at the College of Architecture, Arts and Humanities in Lee Hall. This branch has more than 2,000 square feet of space, more than 30,000 volumes, 260 serial titles and seating for 60 users. A second branch, housing the libraries' manuscripts, rare books and University archives, is located in the Strom Thurmond Institute Building. This facility, specifically designed to house and protect these special items, also provides user space.

Except for adjustments in scheduling during holiday periods, the Cooper Library is open Monday-Thursday 7:45 a.m.-1:00 a.m., Friday 7:45 a.m.-8:00 p.m., Saturday 10:00 a.m.-6:00 p.m. and Sunday 12 noon -1:00 a.m.

Graduate students are granted an extended six-week loan period and are allowed to check out a total of three journals (either bound or current) for a three-day loan period. Lockers are available to commuting graduate students on a semester-by-semester basis. The standard library policies for check out, due date and recalls apply to graduate students. Information about the policies is provided at library service points or can be obtained by calling the Information Desk at (864) 656-3027.

## International Programs and Services

The Office of International Programs and Services (OIPS) assists all international students and exchange visitors in academic, financial, social and personal matters relating to their nonresident visa status. It also serves as the official liaison between Clemson University and the U.S. Immigration and Naturalization Service (INS) and the U.S. Information Agency (USIA). Upon arrival at Clemson University, international students and exchange visitors should immediately contact OIPS. The office is located in E-208 Martin Hall, telephone (864) 656-2357.

### Students

Among the primary services OIPS provides international students are (1) preparing and issuing documents (Immigration Form I-20 or USIA Form IAP-66) for securing visas before they come to the United States; (2) advising students on INS regulations and procedures; (3) assisting with completion of paper work to maintain legal status while enrolled at Clemson; (4) providing registration assistance; (5) determining employment and practical training eligibility; (6) generally interpreting University policy and procedures; and (7) facilitating a smooth adjustment to Clemson University and the city through initial orientations and ongoing workshops.

Admission services for international students are provided jointly by the Graduate School and OIPS. International students who come from abroad or transfer from another school must meet academic, language and financial qualifications as determined by Clemson University. The general portion of the Admission Test (GMAT), Test of English as a Foreign Language (TOEFL) and transcripts of all previous academic studies are some of the determinants used for appraising academic and language ability. Financial qualifications are determined by the submission of financial assessment and bank statements verifying adequate funding. These documents must be received by the University before Form I-20 (or IAP-66) is issued.

### Application Deadlines

1. *Students from Abroad.* Completed applications for admission of prospective international students from abroad must be received by the Graduate School by May 1 and October 1 for registration in the subsequent fall and spring semesters, respectively. Every required item in support of the application must be on file with the Graduate School by these dates. Thus, international applicants living outside the United States should complete the required standardized tests at least three months prior to May 1 or October 1, as appropriate. Documents for a student visa will be issued no later than June 15 and November 1 for registration in the fall and spring semesters, respectively. Initial enrollment of international students in the summer sessions is strongly discouraged and is permitted only on rare occasions.

The information below applies to all international students from abroad.

For enrollment in:	Fall Semester	Spring Semester
Completed application	May 1	October 1
Action by department	June 1	October 15
Issuance of documents*	June 15	November 1

2. *Students Living in the United States.* Students in F-1 visa status will not require Form I-20 until after registering for classes. After completing the enrollment process, certification will be made on page 4 of the I-20, and pages 1 and 2 will be sent to INS to complete the transfer. OIPS will send the student a Transfer Clearance Form and a Financial Certification Form to be completed prior to issuance of the Form I-20 or IAP-66.

\*Action taken by the Office of International Programs and Services (OIPS) after review by the department and acceptance by the Graduate School. Evidence of funding must be available to OIPS at this time.



The information below applies only to F-1 visa holders already in the United States.

For enrollment in:	Fall Semester	Spring Semester
Completed application*	June 15	November 1
Action by department	July 15	December 1
Issuance of documents**	Dependent on visa type	Dependent on visa type

Students in J-1 visa status wanting to transfer to Clemson's Exchange Visitor Program must obtain written release from their present Exchange Visitor Program sponsor on a newly issued Form IAP-66 from Clemson University and should adhere to the deadlines above.

### Application Fee and Time Limit

International applicants must submit a \$35\*\*\* nonrefundable application fee with the application material. Without this fee, applications will not be processed. **No application fee waivers are granted by Clemson University.** Generally, acceptance under an application is valid for one year beyond the initial date desired for enrollment. Academic departments reserve the right to deny deferred admission because of limited space and/or resources. Thus, students wishing to defer an enrollment must request and receive written approval for such action from the respective department.

After an application has become invalid, a student must reapply to the University by submitting a new application, including the required fee. Students may also need to resubmit all academic supporting materials requested in the application.

### Employment and Financial Assistance

Financial assistance is available to Clemson's international graduate students through a limited number of highly competitive instructional and research assistantships. Assistantships are awarded by individual departments (see "Departmental Graduate Assistantships" on page 21), and the student must write directly to the department regarding the availability of assistantships. The student will be notified directly by the department only in the event of an awarded assistantship.

Special employment regulations for international students are determined by INS. Thus, to ensure compliance with these regulations, international students must obtain permission from the Office of International Programs and Services before gaining employment at Clemson. Nonacademic employment opportunities are available on campus on a first-come basis. Applications are made directly to the hiring source upon arrival on campus. Off-campus employment generally is unavailable to international students and should not be considered as a means of support. Application for Practical Training and certain other categories of employment may be made after one academic year. Further information is available in OIPS.

### Academic Requirements

All full-time international graduate students are required to carry a minimum of nine hours per semester. Maximum credit hours are discussed under "Enrollment Limits" on page 26. Students with assistantships must meet the prevailing requirements for the assistantship. For specific information, see "Graduate Appointments" on page 21.

### Visa Requirements for Sponsored Students

International students will apply for the type of visa required by their sponsor (government, agency or local department providing funds for study at Clemson). If the sponsor has no such requirement and no clear guidelines otherwise are available, Form

I-20 will be issued for requesting an F-1 visa. International students sponsored by their governments or by an agency promoting international education cannot change degree objectives without the written consent of the sponsor.

### Fees and Expenses

Health care and related medical expenses in the United States are costly; therefore, health and accident insurance is required of all international students and accompanying family members. On-campus housing is arranged directly by the student with the University Housing Office. Applications for on-campus housing are sent by OIPS to the student along with the documents for visa application. Off-campus housing is arranged entirely by the student.

International students will pay these estimated annual costs (2 semesters and summer) to attend Clemson University.

	Graduate Students	Graduate Assistants
Academic fees	\$7,284*	\$1,228*
Medical fee	\$258*	\$258*
Medical insurance	\$549*	\$549*
Living expenses	\$9,600*	\$9,600*
Total costs	\$17,691*	\$11,635*

These costs are estimates for the 1996-97 calendar year and are subject to change without notice. The amount of funds students must have on hand to enter the United States (approximately one-third of the annual cost) is indicated on the visa documents issued by Clemson to international students. Documents for obtaining a visa (I-20s or IAP-66s) will not be issued without the required verification which indicates the student has access to, as a minimum, the amounts indicated above before entering the United States.

### Exchange Visitors

The exchange visitor (hereafter referred to as visitor) is a foreign national in J-1 visa status who is associated with an academic department on campus or an affiliated institute or organization for purposes other than seeking a degree from Clemson University. The visitor status is formalized by an invitation from a department of Clemson University to apply for the exchange visitor status, completion of an Exchange Visitor Application, acceptance by the inviting department and issuance of Form IAP-66 from OIPS. Confirmation of English ability and academic degree is required prior to arrival.

A monthly administrative fee commensurate with the current costs of a regularly enrolled international graduate student will be required unless waived by the department. Visitors will be assessed a one-time charge of \$150\* by OIPS. Health and accident insurance are required for the entire period of stay in the U.S.

Services provided by OIPS include assisting the visitor with USIA requirements; ensuring that visitors obtain insurance; serving as a liaison on program objectives among program agency sponsors, academic departments and the visitor; and providing updated progress reports when requested.

## STUDENT SERVICES

### Career Center

The Career Center coordinates campus visits for hundreds of representatives from business, industry and government who are interviewing graduate students for permanent employment and summer internships. Recruiters are scheduled from September through April. Clemson University has one of the most sophisticated placement systems in the country, which allows students to research employers and sign up for interviews from any campus terminal connected to the mainframe.

\* Every required item in support of the application must be on file with the Graduate School by these dates.

\*\* Financial Certification and Transfer Clearance Forms must be received by OIPS before Form I-20 or Form IAP-66 will be issued.

\*\*\* Subject to change.

\* Subject to change.



Graduate students are encouraged to attend seminars on writing résumés, interviewing and job-search techniques. Individual career counseling and a computer-assisted career information system are available. All graduate students are encouraged to register with the Placement Office one year before their expected graduation date.

The Career Center is in Room 804 University Union.

### **Food Service**

The University provides several economical meal plans, which are outlined in the food service brochure. Harcombe and Schilleter dining halls feature an unlimited seconds policy, while the Clemson House dining room and the Canteen serve meals on an a la carte basis. Students dining at the Clemson House may use the meal card as a cash equivalency or for a pre-designated meal at no additional cost. Meals may also be purchased on a cash basis or with the Tiger Stripe Account (a declining balance account).

In addition to the standard meal plans designed for frequent diners, the University offers two plans designed specifically for commuters. The Commuter 5 offers lunch Monday through Friday. Any 40 meal plans provide good value for the student on the run.

Meal plans begin immediately after a student obtains a meal plan at the beginning of the semester and end after the evening meal on the day of graduation at the end of each semester. The meal card is personal and may not be transferred or sold.

Students may change meal plans at the billing of spring semester fees with no service charge. Students may change meal plans after the first two weeks and prior to the last six weeks of the semester by paying a \$25\* service charge. Changes may be made at the Tiger 1 Card Office located in Harcombe Hall on Mondays only. All adjustments will be prorated. The only exception is for students withdrawing from the University. Students may upgrade during the registration period.

Meals not eaten during a week are not refunded or held in reserve for use at another time. Only one meal may be eaten during a set meal period.

### **Health Services**

Redfern Health Center consists of three divisions: Counseling and Psychological Services (CAPS), Health Education/Alcohol & Drug Education, and Medical Services. Redfern is an ambulatory outpatient facility that operates Monday through Friday from 7:30 a.m. - 5:00 p.m. Physician care is available Monday through Friday from 8:00 a.m. - 5:00 p.m. (Summer hours 8:00 a.m. - 4:30 p.m.). Students are seen at Redfern throughout the day by appointment. The CU NOW Clinic (a walk-in clinic) is available to those students who do not have an appointment. During the Fall and Spring semesters, ASK-A-NURSE telephone services are available Sunday - Thursday from 4:00 - 8:00 p.m. The student health center offers a variety of services including: counseling and psychological services, outpatient ambulatory care for illnesses and injury, health education/alcohol and drug education, women's health care, nutritional counseling, orthopedic clinics and allergy/immunization clinics.

The \$95\* per semester health fee (summer session fees are prorated) covers the services of the University physicians, psychologists, nurse practitioners and health educators. Included in the health fee is a \$500 per incident excess accident and sickness benefit available for after-hours urgent care. Students who pay the health fee pay reduced costs for pharmaceuticals, laboratory and X-ray co-pays, allergy injections, physical examinations, orthopedic equipment and women's health care. Students are responsible for the cost of consultation with referral physicians and medical or surgical services performed away from campus. Dental and optical care are not offered by the health service but can be obtained locally at the student's expense.

On-campus medical emergencies are transported by the University ambulance to the closest community medical resource. The University ambulance is staffed with certified emergency medical personnel 24 hours a day. Students are required to pay for off-campus ambulance transportation except for those medical resources within the city of Clemson for after-hours urgent care.

### **Insurance**

The University offers a plan of accident and sickness insurance designed to help cover major medical expenses. Information on this insurance plan is sent to all students prior to the beginning of the fall semester. The health center strongly encourages students who do not have adequate insurance coverage to purchase health insurance.

### **Immunization Requirements**

The University requires that all new students have documentation of two red measles (rubeola) vaccinations on or after their first birthday. Those students who were born prior to January 1, 1957, are exempt from the measles requirements. A tuberculin skin test (PPD or Mantoux) is required within the past year. If there is a history of a positive skin test, a chest X-ray is required within the past year. A tetanus toxoid immunization is required within the past ten years. Students not in compliance with immunization requirements will not be allowed to complete registration.

### **After Hours**

During the Fall and Spring semesters, students who have questions about their health needs utilize the ASK-A-NURSE telephone service at (864) 656-2233 (Sunday - Thursday, 4:00 - 8:00 p.m.). A registered nurse is available by telephone to answer questions, provide health information and schedule appointments for practitioners at Redfern.

Students requiring the care of a physician after hours may choose from area emergency rooms and urgent-care facilities. These facilities include Clemson Health Center (an urgent-care facility), Oconee Memorial Hospital, Anderson Area Medical Center, Baptist Medical Center and Greenville Memorial Medical Center.

### **Housing**

#### **Graduate and Undergraduate (Semester Option)**

University housing accommodates nearly 7,000 single students in 20 residence halls, three apartment complexes and the Clemson House, all conveniently located on the main campus and economically priced for both graduate and undergraduate students.

All University housing is air-conditioned, and cable television is provided. Residence hall rooms are equipped with beds, chests of drawers, desks and chairs. Normally, two students are assigned to a room unless the single occupancy option is chosen. Apartments have two bedrooms complete with beds, chests of drawers, desks and chairs, a living room, bathroom and a kitchen. Four students are assigned to each of these units.

Graduate students interested in these accommodations should contact the Housing Office at least six months prior to their date of enrollment. While this housing is designed primarily to meet the needs of undergraduate students, graduate students are encouraged to apply and are given high priority for assignments.

Once the request for housing is received, an application will be sent. Students attending Clemson University for the first time will pay a nonrefundable \$25\* housing application fee. Students previously enrolled at Clemson University will be asked to pay a \$95\* advance housing deposit, which serves as a credit against the semester fees.

---

\* Subject to change.



Rental rates per semester are shown below.

### Residence Halls

Johnstone Hall: Sections A, E, F	\$780*
Donaldson, Bowen, Wannamaker, Bradley, Norris, Benet, Young, Cope, Geer, Sanders, Johnstone Hall: A and F Annexes	\$895*
Clemson House (room)	\$970*
Barnett, Byrnes, Lever, Manning, Mauldin, Smith	\$985*
Holmes, McCabe	\$1,135*

### Apartments

Clemson House (3 or 4 occupants)	\$1,010*
Thornhill Village (4 occupants)	\$1,075*
Calhoun Courts (4 occupants)	\$1,195*
Lightsey Bridge (4 occupants)	\$1,230*

### Graduate Student Housing (Monthly Option)

A significant number of Thornhill Village apartments are designated as the graduate student area with a 12- or 9-month lease option available beginning August 1 of each year. Each Thornhill Village apartment is a two-bedroom unit with a full kitchen, living room and bathroom. Close proximity to the center of campus, convenient parking and laundry facilities, cable television and nightly security staff add to the appeal of this complex. Special extensions on the lease are available for December graduates. Each apartment is double occupancy, thus allowing adequate space for privacy and an area conducive for studying.

Graduate students who choose to live in this area sign a lease and pay a \$200\* security deposit. This deposit is refundable through June 1. After June 1, only those students not enrolling for the fall semester will be released from the lease agreement. Monthly payments of \$315\* for a 12-month lease and \$345\* for a 9-month lease are due on the fifth day of each month. (All utilities, cable television and local telephone service are included.) The first month's rent is due when a resident checks in and takes possession of the apartment key.

Further information can be obtained by writing the Housing Office, Clemson University, 200 Mell Hall, Box 344075, Clemson, SC 29634-4075 or by calling (864) 656-2295.

### Family/Faculty Housing

The University provides comfortable and economical family housing apartments, including two-bedroom townhouse apartments, two-bedroom duplex apartments and three-bedroom duplex apartments for married and single-parent students. All units have washer and dryer hookups.

#### Monthly rental fees are:

2 Bedroom Townhouse	\$290*
2 Bedroom Duplex	\$315*
3 Bedroom Duplex	\$365*
3 Bedroom Faculty House	\$395* - \$495*

Applications and brochures describing this housing are available upon request. Students must have a graduate assistantship or fellowship to qualify for family/faculty housing. Further information can be obtained by writing the Family Housing Office, Clemson University, 101 Mell Hall, Box 344075, Clemson, SC 29634-4075 or by calling (864) 656-0829.

### International Students and Exchange Visitors

Students in F-1 visa status transferring from within the United States will receive on-campus housing information from OIPS upon submitting the Transfer Clearance Form. Students coming from abroad will receive on-campus housing information from OIPS along with the Form I-20 or Form IAP-66. There being no permanent on-campus housing available to J-1 exchange visitors, housing arrangements for visitors not registering for classes are

made with the assistance of the hosting academic department or affiliated institute/organization.

### Students with Disabilities

Clemson University is committed to providing equal opportunities to all students and assisting them in making their college experience successful and positive. Individuals with disabilities requesting accommodations must provide current documentation of their disability from their physician or other appropriate professional to the Office of Student Disability Services at 707 University Union. Appropriate accommodations are developed individually with the coordinator of student disability services, (864) 656-0515.

## RESIDENCE REQUIREMENTS

### Application for Resident Status

Any prospective or enrolled graduate student, whose status concerning entitlement to payment of in-state tuition and fees is uncertain, has the responsibility of securing a ruling from the University by providing all relevant information on special application forms. These forms can be obtained from the Graduate School Office and are to be completed and returned to that office at least two weeks prior to registration for any semester or summer term for which the student is attempting to qualify for payment of in-state tuition and fee rates.

By law, the burden of proof for establishing eligibility is on the student. Therefore, residence applications should be prepared in a complete and accurate manner and should be accompanied by adequate documentation. Once the requisite steps to establish residence and domicile have been taken, the position and validity of the claim will be evaluated.

The residence officer will review the application and supporting documentation which is provided and render a judgment as soon as possible (usually at least two weeks). There may be circumstances, however, that require extensive documentation which could result in extended review periods for certain applications.

### Domicile Requirements

South Carolina law provides that independent persons who reside in and have been domiciled in South Carolina for a period of no less than 12 months with an intention of making a permanent home in South Carolina, and their dependents, may be considered eligible for in-state rates on tuition and fees while attending South Carolina state-supported colleges and universities. **Please realize that merely residing in the state for a year does not satisfy the domicile requirement.** The 12-month domicile period is not measured until after the independent person takes positive steps which establish a legal connection to South Carolina and reflect an intent to establish a permanent home in South Carolina. In other words, specific action to affiliate legally with the state of South Carolina will serve generally as the benchmark for the beginning of the 12-month waiting period.

### Penalties for Willful Misrepresentation

Individuals who make willful misrepresentations of fact relative to their claims to South Carolina residence shall be charged tuition and fees past due and unpaid at the out-of-state rate, plus interest at a rate of 8 percent per annum, plus a penalty amounting to 25 percent of the out-of-state rate for one semester. Until these charges have been paid, no such student shall be allowed to receive transcripts or graduate from Clemson University or any state institution.

\* Subject to change.



## Resident Tuition and Fees

**Application for Resident Status** — Any undergraduate student or prospective student whose status concerning entitlement to payment of in-state tuition and fees is uncertain has the responsibility of securing a ruling from the University by providing all relevant information on special application forms. These forms can be obtained from the Office of Admissions and Registration and are to be completed and returned to that office at least two weeks prior to registration for any semester or summer term for which the student is attempting to qualify for payment of the in-state tuition and fee rate.

**Entitlement** — Eligibility for payment of in-state tuition and fees shall be determined under the provisions of Sections 59-112-10 through 59-112-100, South Carolina Code of Laws, 1976, as amended. This law is set forth in its entirety as follows (subject to further amendment by the General Assembly).

**Definitions** — Section 59-112-10. As used in this chapter:

- A. The words "State Institution" shall mean those post-secondary educational institutions under the jurisdiction of the following: (1) Board of Trustees, Clemson University; (2) Board of Trustees, Medical University of South Carolina; (3) Board of Trustees, South Carolina State College; (4) State College Board of Trustees; (5) Board of Visitors, The Citadel; (6) Board of Trustees, University of South Carolina; (7) Board of Trustees, Winthrop College; and (8) State Board of Technical and Comprehensive Education.
- B. The word "student" shall mean any person enrolled for studies in any state institution.
- C. The word "residence" or "reside" shall mean continuous and permanent physical presence within this State, provided, that temporary absences for short periods of time shall not affect the establishment of a residence.
- D. The word "domicile" shall mean a person's true, fixed, principal residence and place of habitation; it shall indicate the place where such person intends to remain, and to which such person expects to return upon leaving without establishing a new domicile in another state. For purposes of this section one may have only one legal domicile; one is presumed to abandon automatically an old domicile upon establishing a new one. Housing provided on an academic session basis for students at State institutions shall be presumed not to be a place of principal residence, as residency in such housing is by nature temporary.
- E. The words "in-state rates" shall mean charges for tuition and fees established by State Institutions for persons who are domiciled in South Carolina in accordance with this act; the words "out-of-state rates" shall mean charges for tuition and fees established by State Institutions for persons who are not domiciled in South Carolina in accordance with this act.
- F. The words "independent person" shall mean a person in his majority, or an emancipated minor, whose predominant source of income is his own earnings or income from employment, investments, or payments from trusts, grants, scholarships, loans, or payments of alimony or separate maintenance made pursuant to court order.
- G. The words "dependent" or "dependent person" mean: (1) one whose financial support is provided not through his own earnings or entitlements, but whose predominant source of income or support is payments from a parent, spouse, or guardian, and who qualifies as a dependent or an exemption on the federal tax return of the parent, spouse, or guardian; or (2) one for whom payments are made, under court order, for child support and the cost of his college education by an independent person meeting the provisions

of Section 59-112-20 A or B. However, the words "dependent" or "dependent person" do not include a spouse or former spouse who is the recipient of alimony or separate maintenance payments made pursuant to court order.

- H. The word "minor" shall mean a person who has not attained the age of eighteen years; and the words "emancipated minor" shall mean a minor whose parents have entirely surrendered the right to the care, custody and earnings of such minor and are no longer under any legal obligation to support or maintain such minor.
- I. The word "parent" shall mean a person's natural or adoptive father or mother; or if one parent has custody of the child, the parent having custody; or if there is a guardian or other legal custodian of such person, then such guardian or legal custodian; provided, however, that where circumstances indicate that such guardianship or custodianship was created primarily for the purpose of conferring South Carolina domicile for tuition and fee purposes on such child or dependent person, it shall not be given such effect.
- J. The word "spouse" shall mean the husband or wife of a married person.

**South Carolina Domicile Defined for Purposes of Rates of Tuition and Fees** — Section 59-112-20. South Carolina Domicile for tuition and fee purposes shall be established as follows in determinations of rates of tuition and fees to be paid by students entering or attending State Institutions:

- A. Independent persons who reside in and have been domiciled in South Carolina for a period of no less than twelve months with an intention of making a permanent home herein, and their dependents, may be considered eligible for in-state rates.
- B. Independent persons who reside in and have been domiciled in South Carolina for fewer than twelve months but who have full-time employment in the State, and their dependents, may be considered eligible for in-state rates for as long as such independent person is employed on a full-time basis in the State.
- C. Where an independent person meeting the provisions of Section 59-112-20 B above, is living apart from his spouse, or where such person and his spouse are separated or divorced, the spouse and dependents of such independent person shall have domiciliary status for tuition and fee purposes only under the following circumstances: (1) if the spouse requesting domiciliary status for tuition and fee purposes remains domiciled in South Carolina although living apart or separated from his or her employed spouse, (2) if the dependent requesting domiciliary status for tuition and fee purposes is under the legal custody or guardianship, as defined in Section 59-112-10I above, of an independent person who is domiciled in this State; or if such dependent is claimed as an income tax exemption by the parent not having legal custody but paying child-support, so long as either parent remains domiciled in South Carolina.
- D. The residence and domicile of a dependent minor shall be presumed to be that of the parent of such dependent minor.

**Effect of Change of Residency** — Section 59-112-30. When the domicile of a student or of the person upon whom a student is financially dependent changes after enrollment at a State Institution, tuition charges shall be adjusted as follows:

- A. Except as provided in Section 59-112-20B above, when domicile is taken in South Carolina, a student shall not become eligible for in-state rates until the beginning of the next academic session after expiration of twelve months from date of domicile in this State.



B. When South Carolina domicile is lost, eligibility for in-state rates shall end on the last day of the academic session in which the loss occurs; however, application of this subsection shall be at the discretion of the institution involved.

C. Notwithstanding the other provisions of this section, any dependent person who has been domiciled with his family in South Carolina for a period of not less than three years immediately prior to his enrollment may enroll in a state-supported institution of higher learning at the in-state rate and may continue to be enrolled at such rate even if the parent, spouse, or guardian upon whom he is dependent moves his domicile from this State.

*Effect of Marriage* — Section 59-112-40. Except as provided in Section 59-112-20 above, marriage shall affect determinations of domicile for tuition and fee purposes only insofar as it operates to evince an intention by the parties to make a permanent home in South Carolina.

*Military Personnel and Their Dependents* — Section 59-112-50. Notwithstanding other provisions of this act, during the period of their assignment to duty in South Carolina members of the armed services of the United States stationed in South Carolina and their dependents may be considered eligible for in-state rates. When such armed service personnel are ordered away from the State, their dependents may continue for an additional twelve months to have this eligibility at the State Institutions where they are enrolled at the time such assignment ends. Such persons and their dependents may be considered eligible for in-state rates for a period of twelve months after their discharge from the armed services even though they were not enrolled at a State Institution at the time of their discharge, if they have evinced an intent to establish domicile in South Carolina and if they have resided in South Carolina for a period of at least twelve months immediately preceding their discharge.

*Faculty, Administrative Employees and Dependents Thereof* — Section 59-112-60. Full-time faculty and administrative employees of State Institutions, and the spouses and children of such persons, shall be excluded from the provision of this act.

*Abatement of Rates for Nonresidents on Scholarship* — Section 59-112-70. Notwithstanding other provisions of this act, the governing boards listed in Section 59-112-10 A above, are authorized to adopt policies for the abatement of any part or all of the out-of-state rates for students who are recipients of scholarship aid.

*Administration of Chapter; Burden of Proving Eligibility of Students* — Section 59-112-80. Each State Institution shall designate an official to administer the provisions of this act. Students making application to pay tuition and fees at in-state rates shall have the burden of proving to the satisfaction of the aforesaid officials of State Institutions that they have fulfilled the requirements of this act before they shall be permitted to pay tuition and fees at such rate.

*Penalties for Willful Misrepresentation* — Section 59-112-90. Where it appears to the satisfaction of officials charged with administration of these provisions that a person has gained domiciliary status improperly by making or presenting willful misrepresentations of fact, such persons should be charged tuition and fees past due and unpaid at the out-of-state rate, plus interest at a rate of eight percent per annum, plus a penalty amounting to twenty-five percent of the out-of-state rate for one semester; and until these charges have been paid no such student shall be allowed to receive transcripts or graduate from any State Institution.

*Regulations* — Section 59-112-100. The Commission of Higher Education may prescribe uniform regulations for application of the provisions of this act and may provide for annual review of such regulations.

*Regulatory Guidelines* — *Commission on Higher Education, Chapter 62*. Statutory Authority: 1976 Code Sections 59-112-10 to 59-112-100, Determination of Rates for Tuition and Fees.

#### *Rates of Tuition and Fees* — Section 62-600

A. Resident classification is an essential part of fee determination, admission regulations, and other relevant policies of State institutions. It is important that such institutions have fair and equitable regulations which can be administered consistently and are sensitive to the interests of both students and the State. The Commission on Higher Education hereby establishes regulations for the Statute Governing Residency and Tuition for Fee Purposes to be applied consistently by all South Carolina institutions of higher education. These regulations do not address residency matters relating to either in-county or international categories used within the State's technical colleges.

B. Institutions of higher education are required by the Statute to determine the residence classification of applicants. The initial determination of one's resident status is made at the time of admission. The determination made at that time, and any determination made thereafter, prevails for each subsequent semester until the determination is successfully challenged. The burden of proof resides with the students to show evidence as deemed necessary to establish their residency status.

#### *Code of Laws Governing Residence* — Section 62-601

A. The rules regarding the establishment of legal residence for tuition and fee purposes for institutions of higher education are governed by the South Carolina Code of Laws.

B. As prescribed by the code, residence for tuition and fee purposes can be established by (1) independent persons, (2) dependent persons, and (3) independent immigrants, or dependent immigrants.

#### *Definitions* — Section 62-602

A. A "resident student" for tuition and fee purposes is defined as an independent person who has abandoned all prior domiciles and has been domiciled in South Carolina continuously for at least twelve months immediately preceding the first day of classes of the term for which resident classification is sought and for whom there is an absence of such evidence in other states or countries, notwithstanding other provisions of the Statute. In the instances of dependent students and their families who are citizens or permanent residents, the domicile of the spouse, parent, and/or guardian for at least the twelve months immediately preceding the first day of classes of the term for which resident classification is sought is considered in determining residency status.

B. "Reside" is defined as continuous and permanent physical presence within the State, provided that temporary absences for short periods of time shall not affect the establishment of residence.

Temporary absences shall be absences which are thirty days or less. Excluded are absences associated with requirements to complete a degree, absences for military training service, and like absences, provided South Carolina domicile is maintained. Absences of more than thirty days may affect the establishment or maintenance of residence for tuition and fee purposes. In the instance of dependents, except for non-resident aliens, where the spouse, parent and/or guardian "reside" will be considered in determining residency status.



- C. "Domicile" is defined as true, fixed, principal residence and place of habitation, indicating where a person intends to remain, or to where one expects to return when away. Generally, an applicant must be domiciled in the State for twelve months for residency consideration.
- D. "Independent Person" is defined as one in his/her majority (eighteen years of age or older), whose predominant source of income is his/her own earnings or income from employment, investments, or payments from trusts, grants, scholarships, loans, or payments made in accordance with court order. An independent person must provide more than half of his/her support during the twelve months immediately prior to the date that classes begin for the semester for which resident status is requested and cannot be claimed as a dependent or exemption on the federal tax return of his/her parent, spouse, or guardian for the year in which resident status is requested.
- E. "Dependent Person" is defined as one whose predominant source of income or support is from payments from a parent, spouse, or guardian and who qualifies for and is claimed as a dependent or exemption on the federal income tax return of the parent, spouse, or guardian. A dependent person is also one for whom payments are made, under court order, for child support and the cost of the dependent person's college education.
- F. "Terminal Leave" is defined as a transition period following active employment and immediately preceding retirement (with a pension or annuity), during which the individual may use accumulated leave.
- G. "Immediately Prior" is defined as a period of time not exceeding ninety days and immediately preceding the first day of classes for the term in question.
- H. "Continue to be Enrolled" is defined as continuous enrollment without an interruption that would require the student to pursue a formal process of readmission to that institution. Formal petitions or applications for change of degree level shall be considered readmissions.
- I. "Non-resident Alien" is defined as a person who is not a citizen or permanent resident of the United States. By virtue of their non-resident status "non-resident aliens" generally do not have the capacity to establish domicile in South Carolina.
- J. "Academic Session" is defined as a term or semester of enrollment.

#### *Citizens and Permanent Residents — Section 62-603*

- A. Independent persons who have physically resided and been domiciled in South Carolina for twelve continuous months immediately preceding the date the classes begin for the semester for which resident status is claimed may qualify to pay in-state fees. The twelve-month residency period does not start until the independent person begins to take steps which indicate that the independent person intends to establish a permanent home in the State. Absences from the State for more than thirty days during the twelve-month period may affect the establishment of permanent residence for fee and tuition purposes. Steps an independent person should take to establish a permanent home in South Carolina are listed in the section entitled "Establishing the Requisite Intent to Become a South Carolina Domiciliary."
- B. The resident status of a dependent person is based on the resident status of the person who provides more than half of the dependent person's support and claims the dependent person as a dependent for federal income tax purposes. The residence and domicile of a dependent minor and other de-

pendent persons shall be presumed to be that of their parent(s), spouse, or guardian(s).

- C. In the case of divorced or separated parents, the resident status of the dependent person may be based on the resident status of the parent who supports and/or claims the dependent person as a dependent for tax purposes, or it may be based on the resident status of the parent who has legal custody of the dependent person.

#### *Non-resident Aliens, Non-citizens, and Non-permanent Residents — Section 62-604*

- A. Except as otherwise specified in this section, all non-citizens and non-permanent residents of the United States will be assessed tuition and fees at the non-resident, out-of-state rate. Independent aliens, including refugees, untainted, and parolees and their dependents, may be entitled to resident, in-state classification once they have been awarded permanent resident status by the U.S. Department of Justice and meet all the statutory residency requirements provided that all other domiciliary requirements are met. Time spent living in South Carolina immediately prior to the awarding of permanent resident status may not be counted towards the twelve month residency period. Certain non-resident aliens present in the United States in specified visa classification may be granted in-state residency for tuition and fee purposes as prescribed by the Commission on Higher Education.
- B. The *Adviser's Manual of Federal Regulations Affecting Foreign Students and Scholars* will serve as the primary resource reference for defining visa categories.

#### *Establishing the Requisite Intent to Become a South Carolina Domiciliary — Section 62-605*

- A. Residence status may not be acquired by an applicant or student while residing in South Carolina for the sole purpose of enrollment in an institution or for access to state-supported programs designed to serve South Carolina residents.
- B. If a person asserts that his/her domicile has been established in this State, the individual has the burden of proof. Such persons should provide to the designated residency official any and all evidence which the person believes satisfies the burden of proof. The residency official will consider any and all evidence provided concerning such claim of domicile, but will not necessarily regard any single item of evidence as conclusive evidence that domicile has been established.
- C. For independent persons, examples of intent to become a South Carolina resident may include, although any single indicator may not be conclusive, indicia as listed below. The absence of indicia in other states or countries is required before the student is eligible to pay in-state rates. Indicia may include:
  1. statement of full-time employment;
  2. possession of a valid South Carolina voter registration card and voting in South Carolina elections;
  3. designating South Carolina as state of legal residence on military record;
  4. possession of a valid South Carolina driver's license, or if a non-driver, a South Carolina identification card;
  5. possession of a valid South Carolina vehicle registration card;
  6. continuous presence in South Carolina during periods when not enrolled as a student;
  7. paying South Carolina income taxes as a resident during the past tax year, including income earned outside of South Carolina from the date South Carolina domicile was claimed;



8. ownership of principal residence in South Carolina; and
  9. licensing for professional practice (if applicable) in South Carolina.
- D. These indicia will likewise be considered for spouses, parents, and guardians of dependent persons who wish to establish South Carolina domicile. As noted under "Citizens and Permanent Residents" above, the resident status of a dependent person matches that of the person who provides more than half of the dependent person's support and claims the dependent person as a dependent for federal tax purposes.

#### *Maintaining Residence — Section 62-606*

- A. A person's temporary absence from the State does not necessarily constitute loss of South Carolina residence unless the person has acted inconsistently with the claim of continued South Carolina residence during the person's absence from the State. The burden is on the person to show retention of South Carolina residence during the person's absence from the State. Steps a person should take to retain South Carolina resident status for fee and tuition purposes include continuing to use a South Carolina permanent address on all records; retaining South Carolina voter's status; voting by absentee ballot; maintaining South Carolina driver's license; maintaining South Carolina vehicle registration; satisfying South Carolina resident income tax obligation. Individuals claiming permanent residence in South Carolina are liable for payment of income taxes on their total income from the date that they established South Carolina residence. This includes income earned in another state or country.
- B. South Carolina residents (and their dependents) who serve in the military may continue to be eligible to pay in-state fees as long as they continuously claim South Carolina as their state of legal residence during their military service. South Carolina residents who change their state of legal residence while in the military lose their South Carolina resident status for fee and tuition purposes. To re-establish their South Carolina resident status, such persons must take steps which indicate that they plan to re-establish permanent residence in the State. These persons must then physically reside in the State for twelve continuous months.

#### *Effect of Change of Residency — Section 62-607*

- A. Notwithstanding other provisions of this section, any dependent person, except as otherwise excluded, who has been domiciled with his/her family in South Carolina for a period of not less than three years immediately prior to enrollment at State supported colleges and universities may enroll in those institutions of higher learning at in-state rates and may continue to be enrolled at such rates even if the person upon whom he/she is dependent moves his/her domicile from this State.
- B. If a dependent or independent person has been domiciled in South Carolina for less than three years, eligibility for in-state rates shall end on the last day of the academic session during which domicile is lost.

#### *Effect of Marriage — Section 62-608*

- A. In ascertaining domicile of a married person, irrespective of gender, such a review shall be determined just as for an unmarried person by reference to all relevant evidence of domiciliary intent.
- B. If a nonresident marries a South Carolina resident, the nonresident does not automatically acquire South Carolina resident status. The nonresident may acquire South Carolina resident status if the South Carolina resident is an independent person and the nonresident is a dependent of the South Carolina resident.

dent person and the nonresident is a dependent of the South Carolina resident.

- C. Marriage to a person domiciled outside South Carolina shall not be solely the reason for precluding a person from establishing or maintaining domicile in South Carolina and subsequently becoming eligible or continuing to be eligible for residency.
- D. No person shall be deemed solely by reason of marriage to a person domiciled in South Carolina to have established or maintained domicile in South Carolina and consequently to be eligible for or to retain eligibility for South Carolina residency.

#### *Exclusions — Section 62-609*

- A. Persons in the following categories may qualify to pay in-state fees without having to establish a permanent home in the State for twelve months. Persons who qualify under any of these categories must meet the conditions of the specific category on or before the first day of classes of the term for which payment of in-state fees is requested.
1. "Military Personnel and their Dependents": Members of the United States Armed Forces (and their dependents) who are stationed in South Carolina on active duty may be considered eligible to pay in-state fees. "Armed Forces" shall mean the United States Air Force, Army, Marine Corps, and Navy. When such personnel are ordered away from the State, their dependents may continue to pay in-state fees for an additional twelve months. Such persons (and their dependents) may also be eligible to pay in-state fees for a period of twelve months after their discharge from the military, provided they have demonstrated an intent to establish a permanent home in South Carolina and they have resided in South Carolina for a period of at least twelve months immediately preceding their discharge. Military personnel who are not stationed in South Carolina and/or former military personnel who intend to establish South Carolina residency must fulfill the twelve-month "physical presence" requirement for them or their dependents to qualify to pay in-state fees.
  2. "Faculty and Administrative Employees, and their Dependents": Full-time faculty and administrative employees of South Carolina state-supported colleges and universities are eligible to pay in-state fees. Dependents of such persons are also eligible.
  3. "Residents with Full-Time Employment and their Dependents": Persons who reside, are domiciled, and are full-time employed in the State and will continue to work full-time until they meet the twelve-month requirement are eligible to pay in-state fees, provided that they have taken the steps to establish a permanent home in the State (see "Establishing the Requisite Intent to Become a South Carolina Domiciliary"). The dependents of such persons are also eligible.
  4. "Retired Persons": Retired persons who are receiving a pension or annuity who reside in South Carolina and have been domiciled in South Carolina as prescribed in the Statute for less than a year may be eligible for in-state rates and State supported aid if they maintain residence and domicile in this State.

Persons on terminal leave who have established residency in South Carolina may be eligible for in-state rates even if domiciled in the State for less than one year, if they present documentary evidence from their employer showing they are on terminal leave. The evidence should show beginning and ending dates for the terminal leave period and that the person will receive a pension or annuity when he/she retires.



- B. Full-time employment shall mean employment which consists of at least thirty-seven and a half hours a week on a single job in a full time status. However, a person who works less than thirty-seven and a half hours a week but receives or is entitled to receive full-time employee benefits shall be considered to be employed full time.
- C. Persons participating in Southern Regional Education Board-sponsored programs, including the Contract for Services and the Academic Common Market programs, must have continuously resided in the State for other than educational purposes for the two years immediately preceding application for consideration and must meet all residency requirements during this two-year period.

#### *Application for Change of Resident Status — Section 62-610*

- A. Persons applying for a change of resident classification must complete a residency application/petition and provide supporting documentation prior to a reclassification deadline as prescribed by the institution.
- B. The burden of proof resides with those persons applying for a change of resident classification who must show required evidence to document the change in resident status.

#### *Incorrect Classification — Section 62-611*

- A. Persons incorrectly classified as residents are subject to reclassification and to payment of all nonresident fees not paid. If incorrect classification results from false or concealed facts, such persons may be charged tuition and fees past due and unpaid at the out-of-state rate. The violator may also be subject to administrative, civil, and financial penalties. Until these charges are paid, such persons will not be allowed to receive transcripts or graduate from a South Carolina institution.
- B. Residents whose resident status changes are responsible for notifying the Residency Official of such changes.

#### *Inquiries and Appeals — Section 62-612*

- A. Inquiries regarding residency requirements and determinations should be directed to the institutional residency official.
- B. Each institution will develop an appeals process to accommodate persons wishing to appeal residency determinations made by the institution's residency official. Neither the primary residency official nor appellate official(s) may waive the provisions of the Statute governing residency for tuition and fee purposes.

## GRADUATE EXPENSES

### *Academic Expenses*

#### **Academic Fees**

1. *Graduate Assistants.* Graduate assistants pay a flat fee of \$460\* per semester and \$154\* for each summer session. Graduate assistants may elect to sign a payroll deduction agreement at the time of registration; however, it should be noted that payroll deductions are not available during summer sessions. The deduction will be for academic fees and/or the health fee, up to the maximum amount due. Details on the deferred payment schedule may be found on page 20 under the heading "Fiscal Policy."

In order for graduate assistants to qualify for this academic fee structure and deferred payment schedule, the assistantship appointment must be made known to the Graduate School by the employing department and the duties must commence within the three-day period following the first day of normal registration in regular semesters. International graduate students are required to be in proper immigration status before any assistantship offer is

extended or attending benefits ensue. Should the assistantship begin after the three-day period, through no fault of the student, the student will receive a refund on a prorata basis for the difference between normal academic fees and those charged as a result of the assistantship.

Likewise, if an assistantship is terminated prior to the end of the regular semester or session, the student may be liable only for a prorated amount of the fee reduction already enjoyed. (See "Termination of Assistantships" on page 22.)

2. *Graduate Fellows and Trainees.* Graduate fellows and trainees pay fees applicable to South Carolina residents, as shown in the next paragraph. Fellowship and traineeship recipients are eligible for appointment as departmental graduate assistants. For students holding both fellowships or traineeships and assistantships, the fee structure for assistantships prevails.

3. *Graduate Students.* Semester charges for graduate students are determined by the credit load, with no distinction between graduate and undergraduate credits.

Graduate students enrolled in 12 or more semester hours during a semester will pay the following:

	South Carolina Resident	Nonresident
Academic Fee	\$1,461*	\$2,922*

Payment of the above fees mandates a health fee but also provides certain entitlements. (See "Related Expenses" on page 20.)

Graduate students enrolled in less than 12 credit hours during a semester will pay the following (except as noted otherwise):

	South Carolina Resident	Nonresident
Academic Fee (per semester hour)	\$120*	\$240*

Students enrolled solely in the M.B.A. program at Furman University or Lander University will pay the following:

	South Carolina Resident	Nonresident
Academic Fee (per semester hour)	\$165*	\$330*
Off-campus (non-MBA)	\$134*	\$268*

Academic fees for classes taught out of state or out of country are determined on the basis of location.

4. *Postbaccalaureate Students.* Postbaccalaureate students pay the same academic fees as graduate students and are subject to out-of-state fees, if applicable.

5. *Permanent University Faculty and Staff.* Permanent Clemson University employees may take up to four credit hours free per semester or summer session. Beyond these hours, they pay the following:

Academic Fee (per semester hour) \$120\*

A permanent employee (as defined by the Clemson University Office of Business and Finance) is a person employed full time (37.5-40 hours per week, 9 or 12 months per year) in a regular position, subject to the full control and responsibility of the University and receiving full remuneration for his or her services in the regular University budget.

Faculty should be aware of the policy restricting pursuit of advanced degrees as found under "University Employees" on page 26.

\* Subject to change.



### Auditing Fees

Full-time students or graduate assistants may audit courses as part of their schedule. Part-time students are charged according to the following schedule:

	South Carolina Resident	Nonresident
Academic Fee (per semester hour)	\$60*	\$120*

Refer to page 29 for the policy on auditing.

### Graduation Fees

The following graduation fees are in addition to the above charges:

Diploma Case	\$ 8*
Mailing fee	\$ 4*
Apparel for Graduation (attendance optional)	
Master's or Education Specialist	
Degree Candidates	\$20*
Doctoral Degree Candidates	\$25*
Binding Fees for Theses or Dissertations, 3 copies (if applicable)	\$24*
Publication of Dissertation Abstract (if applicable)	\$50*

Costs for preparation and duplication of the thesis, dissertation or departmental project report, as well as binding fees for personal copies, are extra charges to be borne by the student.

### Related Expenses

#### Health Fee

All graduate students enrolling in seven or more credits in the fall or spring semester are required to subscribe to the health fee of \$95\* per semester. During the summer sessions, all graduate students enrolling in four or more credits will be required to subscribe to the health fee of \$34\* per regular session. Exemptions to this requirement include students not taking classes on the main campus, international visitors/scholars and employees of Clemson University. Graduate assistants who have authorized a payroll deduction of academic fees may include the cost of the health fee. Any student not mandated to pay the health fee may do so voluntarily and benefit from the services.

The health fee provides for the services of the University physicians, psychologists, nurse practitioners and health educators. Included in the medical fee is an excess accident and sickness benefit available for after-hours urgent care. For more detailed information, see "Health Services" on page 13, or contact Redfern Health Center at (864) 656-2233.

The University offers a plan of accident and sickness insurance designed to help cover major medical expenses. Information on this insurance plan is sent to all students prior to the beginning of the fall semester. The health center strongly encourages students who do not have adequate insurance coverage to purchase the additional coverage.

#### Athletic Contests and University Concerts

Departmental graduate assistants and graduate resident assistants are eligible to purchase two season tickets per sport at the faculty-employee rates. Applications must be completed at the Jervey Athletic Center ticket office.

For full-time graduate students enrolled in 12 or more semester hours, tickets to home football and basketball games are available at no charge upon presentation of a valid ID at times and places published by the Athletic Department. Students are admitted to all other on-campus intercollegiate athletic events, except NCAA-sponsored championship play-off tournaments, upon presentation

of ID. The Athletic Department will make every effort to accommodate all students who want to attend an athletic event. However, when ticket demands are greater than available seats, the Athletic Department reserves the right to refuse to admit students if this would endanger the safety of participants and spectators.

Graduate students, full-time and part-time, may attend University concerts. Announcements on campus determine whether admission is by ticket, by presenting student ID or free.

The ticket privileges just described do not apply to students enrolled solely in the M.B.A. program on the campuses of Furman University or Lander University.

### Vehicle Registration

Vehicles must be registered immediately upon being brought to campus. The cost of vehicle registration is \$48\* for one year, August 15 to August 15. Each additional vehicle is \$6\*, and motorcycle registration is \$18\*. Parking permits and further information may be obtained from Parking Services, Unit 228, University Square, (864) 656-2270.

### Fiscal Policy

#### Settlement of University Fees

The entire amount of the expense for each semester or summer session is due and payable at the beginning of each semester or summer session, and no student is enrolled officially until all expenses are satisfied. In special cases, the University will accept, at the beginning of a semester, a non-interest-bearing promissory note for a portion of the semester residence hall and board fee. In such cases, the note for the first semester charges will be due October 1, and the note for the second semester charges will be due March 1. International graduate students are not eligible for this promissory note.

Upon certification by the dean of the Graduate School and upon authorization by the student of a payroll deduction for payment, deferred payment of academic and health fees may be granted to a student employed as a graduate assistant. The total amount deferred shall not exceed the total of the graduate assistant fees for the semester. Payment of the amount deferred is to be made in six equal installments through payroll deductions beginning with the second pay period of the semester. Should an assistantship be terminated, any unpaid balance of funds deferred is payable immediately as well as any additional fees due. No deferred payments are permitted for summer sessions for any graduate student.

All other transactions relating to payment should be conducted with the Office of Business Affairs. All checks and money orders should be made payable to Clemson University. A personal check given in payment of University expenses which is returned by the bank unpaid immediately creates an indebtedness to the University.

#### Returned Checks/Charge Cards

A check or charge card given in payment of University expenses or a check cashed by the University that is returned unpaid by the bank immediately creates an indebtedness to the University. The Office of Business Affairs, G08 Sikes Hall, administers matters related to the collection of all returned items for students and nonstudents.

The Bursar's Office will redeposit returned checks in payment of academic fees for the fall and spring semesters. A \$20\* service charge will be assessed for each returned item in accordance with state laws. Students with returned items for payment of academic fees are also subject to a late payment fee of \$5\* per calendar day, not to exceed \$350\*, beginning the day after the last day of late registration. If the item was returned to the University in a timely manner and there was no response by the student or drawer, a written request to disenroll the student is made to the registrar. If the request is approved, the percentage of refund will be applied to the debt. If the item is returned after the midpoint of

\* Subject to change.



the semester and there is no response by the student or drawer, a decision will be made by the director of business affairs and the registrar as to the effects of disenrollment. At this point, the student will owe 100 percent of tuition and fees even if he or she has been disenrolled. The University may restrict subsequent payment for academic and other fees by accepting only cash, certified checks, cashier's checks or money orders.

Any individual who cashes a two-party check for payment of University expenses will be held responsible for that check if it is returned unpaid by the bank. Checks used as payment for various University services, such as meal plans, housing, etc., that are later returned unpaid by the bank, give the University the right to cancel such services and cause forfeiture of any refund.

Any returned item not collected may be turned over to a collection agency and the indebtedness reported to a credit bureau. Costs of collection will be added to the debt. Transcripts and diplomas will be withheld pending payment, and the debt may be deducted from state income tax refunds.

Abuse of check cashing and check payment privileges may result in the restriction of such privileges for an indefinite period of time based on the frequency and/or dollar amount, as determined by the Office of Business Affairs.

### Refund of Fees

**Regular Semester.** No refunds will be made on a semester's academic and medical fees after four weeks from the last day to register. In the case of a withdrawal from school, the refund will be based on the effective date of withdrawal as shown on the official University withdrawal form. Refunds for full-time students who drop to part time and part-time students who drop credit hours will be based on the date the course is dropped. To be eligible for a refund, the request must be received by the Office of Business Affairs prior to the beginning of the next term. If a student withdraws prior to the last day to register, the refund is 100 percent. **Beginning with the day following the last day to register**, refunds for periods of four weeks or less during a semester shall be made on the schedule shown below.

Period of Enrollment after Last Day to Register	Percent Refunded
One week or less	80%
More than 1 but not more than 2 weeks	60%
More than 2 but not more than 3 weeks	40%
More than 3 but not more than 4 weeks	20%
More than 4 weeks	0%

**Summer Session.** No refunds of academic and medical fees will be made after three weeks from the last day to register. In the case of a withdrawal from school, the refund will be based on the effective date of withdrawal as shown on the official University withdrawal form. Refunds for students who drop credit hours will be based on the date the course is dropped. To be eligible for a refund, the request must be received by the Office of Business Affairs prior to the beginning of the next term. If a student withdraws prior to the last day to register, the refund is 100 percent. **Beginning with the day following the last day to register**, refunds for summer school sessions shall be made on the schedule indicated below.

Period of Enrollment after Last Day to Register	Percent Refunded by Length of Summer Sessions			
	Less than 3 wks.	3 wks.	5 or 6 wk. session	More than 6 wks.
One week or less	0%	40%	60%	60%
More than 1 but not more than 2 weeks	0%	0%	20%	40%
More than 2 but not more than 3 weeks	0%	0%	0%	20%
More than 3 weeks	0%	0%	0%	0%

### Past Due Student Accounts

Any indebtedness to the University that becomes past due immediately jeopardizes the student's enrollment, and no such student will be permitted to graduate or register for a subsequent semester or summer school term. Further, any student who fails to pay all indebtedness to the University may not be issued a transcript or diploma.

### Establishment of University Fees

The annual State Appropriation Act imposes the general requirement that student fees be fixed by the University Board of Trustees. The act imposes two specific requirements on the Board: (1) In fixing fees applicable to academic and general maintenance and operation costs, the Board must maintain a minimum student fee not less than the fee charged the previous year; (2) In fixing fees applicable to dormitory rental, dining halls, laundry, infirmary and all other personal subsistence expenses, the Board must charge students an amount sufficient to cover fully the cost of providing such facilities and services.

## STUDENT EMPLOYMENT AND FINANCIAL ASSISTANCE

### Graduate Appointments

Approximately 1,850 graduate students hold Clemson University appointments. These are of two kinds: (1) graduate assistantships requiring, for the most part, half-time employment and (2) fellowships or traineeships which require no service to the University.

Clemson University, as a member of the Council of Graduate Schools in the United States, subscribes to the following policy inherent in the resolution adopted by the Council regarding graduate appointments. In every case in which an appointment for the next academic year is offered to an actual or prospective student, the student, if acceptance is indicated before April 15, will have complete freedom through April 15 to submit, in writing, a resignation of the appointment in order to accept one elsewhere. However, an acceptance given or left in force after April 15 commits the student not to accept another appointment (at Clemson or elsewhere) without first obtaining a formal release from the first party to whom a commitment has been made. Similarly, an offer made after April 15 is conditional on presentation by the student of the written release from any previously accepted offer.

To be eligible for any graduate appointment, a graduate student must satisfy the appropriate minimum enrollment requirement described in each section below and the enrollment limit requirements found on page 29. The University reserves the right to withdraw the appointment at any time because of failure to meet these requirements. Graduate students also should understand that an appointment may be withdrawn at any time for failure to maintain a satisfactory academic status including grades [see "Academic Standards (Grading)" on page 28], special examinations and research efforts.

### Departmental Graduate Assistantships

Assistantships are available in academic departments involving primarily instruction, research or extension and in nonacademic departments involving primarily administration. Application forms may be obtained from the Graduate School or from department heads and should be completed and filed early in the academic year before the student enrolls. Selection of assistantship recipients as well as notification of the appointment, its duration and the stipend are the responsibilities of the employing departments. All graduate assistants are granted partial remission of academic and other fees and enjoy certain other benefits provided for University staff personnel.



1. *Eligibility.* To qualify for a departmental assistantship, the graduate student must possess at least a bachelor's degree and be enrolled in a graduate degree program. In addition, the graduate student must devote 10 to 30 hours of service per week to the University and be engaged in employment that bears a recognizable relationship to his or her major field of study. Multiple employment of graduate students by the University (graduate appointment and/or hourly employment) is permitted. It is the responsibility of the secondary employer to receive permission of the primary employer and the Graduate School prior to assignment of any additional work and to ensure that the maximum work load of 30 hours per week is not exceeded. Upper limits on academic loads as related to hours of service per week are found in the section entitled "Enrollment Limits" on page 29.

2. *Minimum Stipend.* The minimum graduate assistantship stipend must be commensurate with a rate 1.2 times the prevailing federal minimum wage.

3. *Minimum Enrollment.* A minimum enrollment is required for appointment as a departmental graduate assistant. During the academic year, the minimum enrollment is nine semester hours for all assistants. Minimum enrollment in the summer sessions is three semester hours per session irrespective of the degree objective. Undergraduate credits may be included in the minimum provided they are relevant to the student's degree program and required by the advisory committee. Credits in GS 799 may be included in the minimum in unusual cases cleared in advance with the Graduate School.

4. *Employment Schedule and Leave without Pay.* Graduate students with 9-month or 12-month graduate teaching assistantship appointments work on the same calendar as faculty with 9-month or 12-month appointments, respectively. Duties over holiday periods for graduate research assistantship appointments should be agreed upon by the student and the immediate faculty advisor in charge of the research program.

A graduate assistant may request up to four weeks of leave without pay per semester and one week of leave without pay per summer session from his or her immediate supervisor for illness of a close family member, death in the immediate family, and personal illness or hardship. If leave is not approved by the administrator of the graduate assistantship, the graduate assistant may petition the Graduate School for approval.

A graduate assistant is eligible for up to six weeks of maternity leave without pay. The request for maternity leave must be made to the department at least one month in advance.

### Graduate Resident Assistantships

Part-time employment on the program staff of the residence halls is available to qualified graduate students. Preference is given to those who have had a successful undergraduate experience as a residence hall assistant. In general, 20 hours of service per week are required, and compensation for such employment amounts to a room or apartment, partial remission of academic and other fees, and approximately \$1,000 per semester. Graduate resident assistants are subject to the enrollment limitation found on page 29, and the required minimum enrollment is coincident with that of departmental graduate assistants. Interested applicants should apply directly to the Housing Office. A personal interview is required prior to final selection.

### Assistantship Appointment Process

Each graduate assistant shall be provided a document to sign and return to the employing department at the time the offer is accepted. The document shall provide a brief description of the expectations of the employer, the anticipated beginning and ending dates, stipend amount, average hours of service per week, work schedule (where appropriate) and the conditions for reappointment, if any. In addition, the assistant must be apprised of the fi-

nancial penalties that may be incurred regarding academic fees should the assistantship start after the beginning or be terminated before the end of the semester or sessions. (See page 19 under "Academic Fees.")

### Termination of Assistantships

1. *Termination of Assistantship by Student.* Normally an assistantship is offered on an annual or on an academic year basis. A student may terminate an assistantship at the conclusion of a semester or summer session without penalty. However, if the student terminates his or her assistantship during a semester, the student may be liable, calculated on a prorata basis, for the difference between the normal academic fees and the reduced fees assessed as a result of the assistantship. If, in the opinion of the immediate supervisor of the assistantship, the termination was justifiable, the administrator may recommend to the dean of the Graduate School that no additional charge be made to the student.

2. *Termination of Assistantship for Cause.* If, in the opinion of the immediate supervisor of the assistantship, a student is not carrying out the duties of the assistantship in a satisfactory manner, the assistantship may be terminated and the student held liable, calculated on a prorata basis, for the reduction in academic fees assessed as a result of the assistantship.

The procedure to be followed before terminating an assistantship for cause follows:

- The immediate supervisor should first discuss the problem with the student and try to resolve the problem. A record of this conversation is placed in the student's departmental file.
- If the performance of the student remains unsatisfactory, a signed written warning from the department head is sent to the student by certified or registered U.S. mail detailing the nature of the problem. The graduate dean shall be notified.
- If the performance of the student remains unsatisfactory, the department head gives the student a written notice of termination. At least two weeks should elapse between the written warning and the notice of termination. The graduate dean shall be notified.

The student has the right to file a grievance with the Commission on Graduate Studies as described on page 29. The assistantship may also be terminated for dropping below the minimum credit hours required as described on this page or for failure to meet other academic requirements.

### Fellowships and Traineeships

Approximately 140 outstanding graduate students hold fellowships or traineeships at Clemson University. In order for a monetary award to be designated a fellowship or a traineeship, it must provide the recipient a minimum of \$1,000 for the academic year. These awards, received from a variety of alumni, foundation, governmental, individual or industrial sources, require no services. Payment in excess of actual educational costs is subject to federal and state taxes.

Graduate Alumni Fellowships, University Research Fellowships and George R. MacDonald Fellowships are University-wide awards administered by the Graduate School. These awards of \$5,000 each for the academic year are made on a competitive basis to nominees selected by the departments. Scholarly potential and academic excellence are the sole criteria for the awards.

Most fellowships and traineeships are administered by the individual colleges and departments. Some awards, such as the Industrial Graduate Residency Fellowships, may limit the student's research to areas of interest to the donor and require a period of residency at the industrial site. Detailed information is available in the colleges or departments.

South Carolina Graduate Incentive Fellowships of \$5,000 for master's students or \$10,000 for doctoral students are available to minority graduate students. These awards are renewable. Master's



students must be citizens of South Carolina. Preference is given to new applicants and those who express a commitment to remain and be employed in the state for two years. These fellowships are administered by the Office of Access and Equity.

Unless stipulated otherwise by the grantor and/or donor, holders of fellowships or traineeships are required to enroll in the same minimum credit load as is applicable to departmental graduate assistants. Continued receipt of any fellowship or traineeship is contingent on the student's maintaining a satisfactory academic status. Normally a student cannot hold concurrently two or more fellowships or traineeships (or the equivalent thereof) administered by the University, regardless of the funding sources. Fellowship recipients are eligible for appointment as departmental graduate assistants. The Graduate School reserves the right to rescind fellowship offers when the total financial package considerably exceeds normal competitive packages.

Fellowships and traineeships usually are offered in early March. Inquiries may be made to the department of the student's major interest or to the Graduate School.

### **Hourly Employment**

Employment on an hourly basis for a portion of a semester or session is possible in some departments. The maximum credit load is the same as that for graduate assistants found under "Enrollment Limits" on page 29. Enrolled graduate students (exclusive of full-time University employees) may not be employed by the University for more than 30 hours per week (graduate appointments and hourly employment combined), and no portion of the hourly employment shall be used to qualify students for benefits afforded those on graduate assistantship appointments.

### **Loans**

The Office of Student Financial Aid administers federal financial aid for graduate students. Many types of federal aid, such as the Federal Pell Grant, are not available to graduate students. However, the Federal Stafford Loan has extended loan limits for graduate students, and is available to most students regardless of income.

U.S. citizens and eligible non-citizens can apply for the Federal Stafford Loan by completing the Free Application for Federal Student Aid (FAFSA). The suggested deadline to apply is April 1 for the following fall semester.

Graduate students accepted into a degree program may borrow funds to cover their established cost of attendance, less any fellowship stipends or fee waivers, up to \$18,500 per year.

Further information and application forms are available from the Office of Student Financial Aid, G01 Sikes Hall, Box 345123, Clemson, SC 29634-5123.

### **Eligibility for Loans**

In order to qualify for a loan, graduate students must be enrolled in at least five credits in a regular semester (Fall or Spring) and three credits for the summer in any combination of enrollments. The Financial Aid Office reserves the right to deny loans in the summer when abnormal enrollments may be contrary to federal loan regulations.

### **Academic Common Market Program**

The State of South Carolina, through its membership in the Southern Regional Education Board (SREB), authorizes its public universities to participate in the Academic Common Market (ACM). Under this program, students who are not residents of South Carolina can enroll in selected graduate programs at Clemson University and pay academic fees appropriate for South Carolina residents provided all of the following conditions are met:

- The student's state of legal residence is AK, AL, FL, GA, KY, LA, MS, OK, TN, TX, VA or WV.

- The desired program of study is: the Ph.D. degree program in ceramic engineering, environmental systems engineering, industrial/organizational psychology or parks, recreation and tourism management; the M.S. or Ph.D. degree program in engineering mechanics, environmental toxicology or nutrition; the M.A. program in professional communication; the M.S. program in applied psychology, applied sociology, architecture or textile chemistry; or, the professional master's program in parks, recreation and tourism management (MPRTM).
- The Coordinating Board in the state of the student's legal residence has selected one of the above programs for its residents.

Programs offered by Clemson University are subject to change without advanced notice. However, students who are enrolled in a program under the ACM provisions prior to its removal by Clemson University are entitled to continue and receive benefits provided they are continuously enrolled (summers excepted) and remain in good academic standing. The Graduate School should be consulted about any and all matters related to the ACM.

### **Special Employment Restrictions**

Graduate students who are employed in programs administered directly or indirectly by Clemson University and are found to be in default on payments of student loans will be subject to wage withholding (garnish) according to Legislative Authority P.L. 102-164; To U.S.C. §1095A et seq.

## **ADMISSION PROCEDURES AND REQUIREMENTS**

### **Procedures**

#### **Application**

Applicants may apply by submitting the normal paper application or by submitting an application electronically on the World Wide Web. The Internet address for Clemson University's Graduate School Netscape server is <http://www.grad.clemson.edu/index.htm>. Applicants may check the status of their application at this same Internet address.

#### **Application Deadlines**

Application for admission of United States citizens and residents should be received no later than five weeks prior to registration. This means that every required item in support of the application (completed application form, application fee, transcripts, letters of recommendation and test scores) must be on file with the Graduate School by this date. Applicants to programs requiring standardized test scores should complete these examinations at least 12 weeks before registration. Unless all admission credentials reach the Graduate School at least five weeks prior to registration, an acceptance cannot be guaranteed. Students applying to a graduate major significantly different from their undergraduate major may anticipate a longer period of time for a decision. A number of programs have earlier deadlines or restrict admission to fall semester only. Students are advised to contact the department for the deadlines of the program of proposed study.

Applications for admission of prospective international students must be completed by May 1 and October 1 for registration in the fall and spring semesters, respectively. This means that every required item in support of the application (completed application form, application fee, transcripts, letters of recommendation, test scores and financial certificate) must be on file with the Graduate School by these dates and that the actual application must have been on file at least four weeks in advance of these dates. Thus, international applicants living outside the United States should complete the required standardized tests at least



three months prior to May 1 or October 1, as appropriate. Issuance of Form I-20 or Form IAP-66 for a student visa will be completed no later than June 15 and November 1 for registration in the fall and spring semesters, respectively. These dates apply to international applicants from abroad. Initial enrollment of international students in the summer sessions is strongly discouraged and is permitted only on rare occasions.

### Application Fee and Time Limit

For applicants wishing to enroll in the Graduate School for the first time, a nonrefundable fee of \$35\* payable to Clemson University via a money order or a check drawn on a United States bank must accompany the application material. Without this fee, applications will not be processed. Generally, acceptance under an application is valid for one year beyond the initial date desired for enrollment, inclusive. However, departments reserve the right to deny deferred admission because of limited space and/or resources. Thus, students wishing to defer enrollment must request and receive written approval for such action from the respective department.

Applicants may apply to two areas without paying an additional \$35\* application fee if both applications are received within the one year time frame. However, a \$35\* application fee will be required for each additional application.

### Disposition of Application Materials

Credentials or supporting materials submitted for admission to the Graduate School become the property of the University and are not returned. Furthermore, no copies will be provided to a third party outside the University even if the applicant requests this release. Copies will be provided to appropriate offices at the University in the interest of academic matters or financial awards relative to the applicant.

## Academic Requirements

### New Applicants

As a minimum and general requirement for admission to any of the University's graduate programs, a prospective student must hold at least a four-year bachelor's degree from an institution whose scholastic rating is satisfactory to the University and must have the approval of the department head or program coordinator in which the major work is planned. Although the quality of an applicant's previous academic record always plays an integral role in any admission decision, a general division in requirements, based on the degree objective, exists as follows:

1. *Master of Arts, Master of Science and Doctor of Philosophy Degrees.* Criteria for admission to these University-wide degrees include satisfactory scores on the general portion of the Graduate Record Examinations (GRE).\*\*

Applicants to the M.S. degree program in industrial management must submit satisfactory scores on the Graduate Management Admission Test (GMAT).\*\* Applicants to the master's program in economics and the Ph.D. degree program in industrial management may submit satisfactory scores on the GMAT\*\* in lieu of the GRE.

2. *The Professional Degrees.* Admission criteria, recommended by the individual colleges awarding the degree, may include professional experience and/or credentials as well as GRE general scores.\*\* Specifically, the professional programs in accounting, business administration and health administration require satisfactory scores on the GMAT\*\*.

International students, in addition to meeting the minimum and general requirement stated previously, must submit satisfactory scores on the general portion of the Graduate Record Examinations\*\* regardless of the degree objective. (However, see items 1 and 2 above for the master's programs in industrial management, accounting and business administration.) A satisfactory score on

the Test of English as a Foreign Language (TOEFL)\*\*\* is also required of international students whose native tongue is not English. The Graduate School may waive this requirement if the applicant has a demonstrated command of the English language.

Admission to all programs is restricted to those students whose academic records clearly indicate they are prepared to benefit from graduate study. The Graduate School reserves the right to require additional quantitative and aptitude examinations as well as personal interviews and/or oral examinations prior to reaching an admission decision. Neither an academic record exceeding minimum requirements, satisfactory scores on standardized tests, nor professional expertise alone will assure a student's admission. Rather, the total record must indicate the likelihood of successful graduate study.

### Assessment of Previous Academic Work

The grade point ratio representing an assessment of an applicant's undergraduate work will be based on the last half of the course work listed on the transcript or transcripts. In conventional cases, this will equate to the full junior and senior years. As a minimum, 60 semester hours (or 90 quarter hours) will be examined, and in no cases will a partial term, session or enrollment period be utilized. Excluded in the computation are courses graded P/F and certain electives having no relationship to a curriculum. Departments are at liberty to discount still other courses in assessing an applicant's academic record. Certain professional programs may use the total undergraduate grade point average to satisfy accreditation standards. In evaluating the grade point ratio of an applicant's graduate work, all graduate course work will be used except research and/or courses graded P/F.

### Conditional Acceptance

Notice of conditional acceptance may be given to highly qualified applicants prior to receipt of the degree they are presently pursuing; however, all requirements for this degree must be completed prior to enrolling in the proposed graduate program at Clemson University. Likewise, conditional acceptance may be given prior to receipt of satisfactory GRE or GMAT scores, if required, but such scores must be received prior to or during the first semester of enrollment.

Clemson University seniors lacking less than a full semester of work to complete the requirements for their bachelor's degrees may apply to a graduate program and, if granted conditional acceptance, be allowed to enroll in courses for graduate credit. Refer to "Clemson University Seniors" on page 26.

### Applicants Presently Enrolled in Graduate School

Students enrolled in a master's degree program at Clemson University who wish to continue their studies in another master's program, a specialist program or a doctoral program after completing their initial degree objective may apply by submitting the normal application, color-coded green. This application must be supported by the student's advisory committee for the master's degree or other faculty designated by the graduate dean who are associated with the applicant's present or proposed program.

Students holding both the bachelor's and master's degrees from Clemson University are encouraged to pursue doctoral programs at other institutions.

### Change of Degree Program

Students who have enrolled in a given degree program within the past two calendar years may request a change of major and/or degree without submitting a new application. Instead, the student must submit to the Graduate School Form GS14 endorsed by the

\* Subject to change.

\*\* GRE or GMAT scores more than five years old relative to date of initial enrollment will not be accepted.

\*\*\*TOEFL scores more than two years old relative to date of initial enrollment will not be accepted.



department head(s) or program chairperson(s) of the affected degree program(s). All program and Graduate School requirements must be met before final approval will be granted.

### Readmission

A former graduate student who has not maintained continuous enrollment (summers excluded), but who is academically eligible to continue in the graduate degree program where he or she was most recently enrolled, may be permitted to return. The procedures are dictated by the period of absence from enrollment as follows:

1. *Less than Two Years.* The student simply notifies the Graduate School and the program coordinator of his or her plans to return.
2. *Two to Six Years.* A new application must be submitted and endorsed by the program coordinator and the Graduate School. The application must show any intervening graduate work, and appropriate official transcripts of the work may be required by the Graduate School.
3. *Six or More Years.* A new application and all supporting materials will be required; that is, such persons are considered to be new applicants.

Former graduate students described above who wish to return to Clemson University to pursue an undergraduate degree and/or course work with no immediate plans for graduate work should contact the Registrar's Office for procedures.

### Academic Renewal

The student who was dismissed from the Graduate School for a grade point deficiency and who has not enrolled for a period of four or more academic years may apply to the Graduate School for readmission under special conditions known as academic renewal. Under these conditions, the previous graduate credits attempted and quality point deficit will not constitute a liability in a new grade point computation. However, no credits passed or their attending quality points will be available to the student for a degree at Clemson, and any courses previously passed may not be validated by special examination. The previous record will appear on the permanent record as well as the notation of readmission under the policy of academic renewal.

### Duplication of Higher Degrees

The duplication of higher degrees is discouraged on the same basis as the duplication of the bachelor's degree. Thus, a student holding a master's degree may not as a rule become a candidate for another master's degree of the same designation, regardless of the field of study. Nor may the holder of a master's degree in a given field, received at another institution, become a candidate for another master's degree in the same field at Clemson.

### Medical Requirements

Graduate students entering Clemson University for the first time receive a medical history form. Prior to registration, the medical form (including immunization documentation) must be completed and returned to the Medical Records Department at Redfern Health Center. Students will not be allowed to complete registration without meeting immunization requirements.

The University requires that all new students have documentation of two red measles (rubeola) vaccinations on or after their first birthday. Those students who were born prior to January 1, 1957, are exempt from the measles requirements. A tuberculin skin test (PPD or Mantoux) is required within the past year. If there is a history of a positive skin test, a chest X-ray also is required within the past year. Students not in compliance with immunization requirements will not be allowed to complete registration.

\* An academic semester is defined as a minimum of nine credit hours of course work not graded pass/fail. An academic year is defined as the total of two academic semesters.

## Admission Classifications

### Admission to a Degree Program

Candidates for admission to a degree program will be admitted in one of the following categories:

1. *Full Status.* The applicant's credentials equal or exceed every minimum admission criterion prescribed for the particular degree.
2. *Provisional Status.* At least one admission criterion prescribed for the particular degree is marginal. Such applicants will be required to remove the provisional status with a satisfactory academic performance during the first semester.\* Doctoral degree applicants will not be admitted provisionally.
3. *Conditional Acceptance.* At least one item required for admission is not available.

In addition to meeting the minimum and general requirements for admission listed under "Academic Requirements" (page 24), the student must be recommended for admission by the program coordinator or department head and must meet any special departmental requirements.

### Admission as a Nondegree Student

Admission in this category is restricted primarily to those persons who may benefit professionally from additional study at the graduate level, for example, public school teachers who are required to complete graduate courses for recertification. In general, the only supportive material required for such admission is a valid transcript showing an appropriate background and confirming the awarding of a bachelor's degree or higher.

Students in the nondegree category may not be candidates for advanced degrees and may not receive a graduate appointment for financial assistance. Should the student subsequently be admitted to a degree program, a maximum of 12 semester hours of graduate credit taken at any campus (nondegree and/or transfer) may be applied toward the degree. In all cases the nondegree student must receive permission from the head of the department before enrolling in graduate courses. This classification is not open to international students.

Students enrolled in a nondegree status are subject to the same academic regulations regarding continuous enrollment as apply to those in a degree program. Refer to page 28.

### Admission as a Postbaccalaureate Student

An applicant may be accepted by the Graduate School as a postbaccalaureate student if he or she applies to a specific graduate degree program and does not have the appropriate academic background. The applicant must be recommended by the department head or program chairperson and must meet all the other requirements for admission to that degree program regarding grade point ratio and standardized test scores. A change in major between the undergraduate and graduate levels may require a longer review time by the department. A student in this category who is denied admission because of failure to meet the minimum requirements has access to the same appeal procedure as any other student applying to the Graduate School.

Applicants will be classified as postbaccalaureate students if they are not qualified to take at least one graduate course per semester that can be included in the minimum hours required for the graduate degree. Additionally, any student required to complete more than 18 semester hours of undergraduate credits will be classified as postbaccalaureate. Until the required number of undergraduate credit hours is less than or equal to 18 and the student is qualified to take a graduate course each semester that can be included in the minimum hours required for the graduate degree, he or she will remain classified as postbaccalaureate. A department or a student may request postbaccalaureate status even though the above criteria are satisfied.



At the time a postbaccalaureate student becomes eligible for classification as a graduate student, he or she must reapply for admission to the Graduate School, and the decision as to eventual admission status (full status or provisional) will be made according to criteria used by the department and the Graduate School for all other applicants to the particular degree program. The postbaccalaureate student is expected to maintain a B average and receive no grade lower than a C to qualify for admission to a graduate program.

Postbaccalaureate students may enroll in the same number of credits per semester as any undergraduate student but cannot enroll in graduate courses (600 level or above) or receive a graduate assistantship. No degree or certificate shall be awarded to students in the postbaccalaureate status, and students who subsequently desire to obtain an additional baccalaureate degree must apply through the Office of Transfer Admissions. The applicability of credits earned toward the undergraduate degree will be determined by the policy pertaining to transfer students. Academic and other fees for postbaccalaureate students shall be those applicable to graduate students with the exception of the application fee and admissions deposit.

A student possessing an undergraduate or graduate degree who wishes to enroll in specific undergraduate courses for reasons other than future admission to the Graduate School shall not be classified as postbaccalaureate and shall be governed by policies established by the Office of Admissions and Registration.

## ***Enrollment in Graduate Courses***

### **Clemson University Seniors**

Enrollment in any graduate course is subject to approval by the department offering the course and the Graduate School. This approval is required prior to registration and may be obtained by completing and returning to the Graduate School office the appropriate form (Form GS6, available at the Graduate School office). The total course work load for the semester must not exceed 18 hours, and the cumulative graduate credits earned by seniors shall not exceed 12 semester hours.

Seniors with a cumulative grade point ratio of 3.0 or higher may enroll in 700- and/or 800-level courses and may choose to use these courses to meet requirements for the bachelor's degree. However, courses used for this purpose cannot be counted later toward an advanced degree. Alternatively, such students may take 600-, 700- or 800-level courses in excess of the requirements for their undergraduate degrees and may request that these courses be included as a part of their graduate program if they are subsequently admitted to the Graduate School at Clemson. Courses cannot be taken at the 600 level if their 300- and 400-level counterparts are required for the undergraduate degree in the same academic major as the proposed graduate degree.

A Clemson senior with a cumulative grade point ratio less than 3.0 may apply to the Graduate School for conditional acceptance as described on page 25. If accepted, the student may enroll in graduate courses for inclusion in a future graduate program, subject to approval of Form GS6. The form must be turned in and accepted by the Graduate School before a student can preregister or register for graduate courses.

In all cases, the credits and quality points associated with senior enrollment in graduate courses will be part of the undergraduate record.

### **Transient Graduate Students**

A student who has been admitted to a degree program at another institution and who wishes to take courses for transfer to that institution may be permitted to enroll as a nondegree student in graduate courses on receipt of Form GS8, Transient Graduate Student Status, which may be obtained from the Graduate School at Clemson University. This form, an abbreviated application to the Graduate School, must be presented two weeks prior to registration.

A student may earn no more than a total of 12 semester hours while in transient status.

### **University Employees**

With the approval of the appropriate dean or director, a qualified employee of Clemson University may pursue graduate work for credit. However, no member of the faculty or staff who has a rank higher than instructor or its equivalent may be considered as a candidate for an advanced degree in the academic department where employed.

Limitations on the number of hours taken per semester are explained under "Enrollment Limits" on page 29.

### **Teacher Certification or Recertification**

Initial certification (endorsement) at the graduate level is available only in educational administration, reading and personnel services (elementary and secondary counseling). Students seeking admission to these programs should hold an appropriate teacher's certificate.

Those who possess a bachelor's degree or higher and who desire initial certification in a teaching area must complete the undergraduate courses needed for certification in a postgraduate status administered by the Office of Transfer Admissions and may not enroll in graduate courses until their eligibility for certification has been established by their major department.

Prospective students should understand that the material in this catalog applies only to requirements for graduate degrees and has no direct relation to certification or recertification for public school teachers. The Graduate School gives no assurance that a program for a graduate degree and a program for a certificate, or recertification thereof, will coincide. Students interested in professional certificates should, prior to beginning any work, confer with the dean of the College of Health, Education and Human Development or the appropriate department head in that college.

### **Restrictions**

Enrollment in any graduate course is subject to approval by the department offering the course and requires permission of the instructor, whether or not such is specifically stated in the course description. To enroll in or receive credit for any courses of the 600 series or above, the student (with the exception of certain Clemson University seniors) must have been officially admitted by the Graduate School either to a degree program (page 25) or as a nondegree student (page 25), or must have been granted conditional acceptance (page 25).

Students may not enroll in 600-level courses for which undergraduate credit has been awarded, nor can graduate credit be awarded retroactively for undergraduate courses already completed.

## **GENERAL GRADUATE SCHOOL REGULATIONS**

Graduate students are subject to the usual procedures and regulations of the University, except as these procedures and regulations apply to undergraduate students only.

Immediately upon enrollment, a student should become acquainted with the degree requirements and the regulations of the Graduate School published in this catalog. Each advisor and student should have a current copy of the graduate catalog.

### ***Procedures to Follow in Pursuing a Degree***

The information presented below is not intended as a step-by-step outline of all procedures to be followed while pursuing a graduate degree. Rather, it is an explanation of primary factors encountered during the process.



## The Major Advisor

A student, with the aid and approval of the department head or program coordinator, must select a major advisor. This advisor must be a member of the program faculty offering the degree and meet the requirements for advisory committee membership described below. In departments or programs with large faculties, new graduate students may be assigned to one professor until each student decides upon a particular interest. This advisor recommends and approves courses to be taken during the student's first semester. The course work selected should be of a fundamental or core nature so the advisory committee will have maximum flexibility to formulate the remainder of the student's program of study.

## The Advisory Committee

The advisory committee approves the student's graduate degree curriculum, supervises the graduate program, administers the final oral examination, and initiates the recommendation for the awarding of the degree. Additionally, the advisory committee may administer qualifying or preliminary and/or final comprehensive examinations. One member of the committee is designated as chairperson or major advisor and normally directs the student's dissertation or thesis, if required. This committee is selected by the student and approved by the department chair or program coordinator. The graduate degree curriculum (GS2) and any recommendations made by the department chair or program coordinator are forwarded to the dean of the college for approval and then submitted to the Graduate School.

A minimum of three faculty members shall be selected for a student seeking a master's or specialist's degree, and a minimum of four faculty members shall be selected for a student seeking a doctoral degree. The majority of the advisory committee, including the major advisor, must be comprised of Clemson University faculty from the department offering the particular degree and who hold full-time positions carrying eligibility for tenure. If a minor is declared, this area must be represented on the committee. Committee members of interdepartmental programs shall be appointed according to bylaws, formulated by the program faculty and endorsed by the Graduate School, that assure appropriate representation of the participating departments.

Part-time and visiting faculty employed by Clemson University may serve on the committee. Persons not employed by the University may serve if they have been appointed to an adjunct faculty status. Part-time, visiting and adjunct faculty may serve as research advisors and will have full voting status on the outcomes of all examinations given by the committee. Inclusion of part-time, visiting and adjunct faculty must not compromise the majority requirements defined above.

The student, department and committee members are notified of the appointments by means of the approved GS2 form.

## Filing of a Graduate Degree Curriculum

A graduate degree curriculum (Form GS2) must be filed with the Graduate School by those students who are in degree programs. Since fixed curricula normally do not exist for graduate degrees, this planned program represents the formulation of an individual student's curriculum as recommended by the advisory committee. It must adhere to departmental as well as Graduate School policies. This program constitutes the core of the student's Graduate Degree Curriculum (Form GS2) and appears on the form at the location entitled REQUIRED COURSES (GRADUATE LEVEL ONLY). Undergraduate deficiencies are listed at the designated location. Supplemental courses, carrying undergraduate or graduate credit and chosen to broaden the student's academic experience, are not required on Form GS2. However, if a listing is desirable, such courses will be listed as departmental requirements at the designated location. Graduate credit is received only for courses numbered 600 or above; no student shall receive both undergraduate and graduate credit for the same course. The

Graduate School discourages inclusion of 600-level courses in the minimum hours required for graduate degrees if these courses are clearly equivalents of undergraduate courses required for an undergraduate degree in the same major at Clemson University. Transfer credit appearing in the curriculum must adhere to the stipulation described under "Acceptance of Transfer Credit" on page 29.

Before a curriculum is approved, it must be reviewed and signed by the advisory committee. It is then submitted to the department chair(s) and college dean(s) for approval and is forwarded to the Graduate School for approval and appropriate distribution of copies.

If it becomes necessary to change the graduate degree curriculum, a revised Form GS2 must be filed. This new form requires all necessary signatures.

Candidates for master's or specialist's degrees should submit the curriculum by the middle of their second semester,\* and doctoral candidates no later than the beginning of their second year\* of study. A \$25\*\* late fee is assessed a student whose GS2 is submitted after the deadline dates, and increases at the rate of \$5\*\* per day thereafter (excluding Saturday, Sunday or University holidays).

## Admission to Candidacy for a Degree

Admission to the Graduate School does not qualify a student as a candidate for an advanced degree. Such candidacy depends upon the acceptance by the graduate dean of a written request for admission to candidacy. This request (Form GS4) may be filed by the student as follows: for the master's degree, after completion of 15 hours of course work; for the Ph.D. degree, after completion of a major share of course work and successful completion of the comprehensive examination (page 37).

All students desiring admission to candidacy must have received full status admission to the Graduate School, have a satisfactory academic standing, and have on file an approved graduate degree curriculum (Form GS2).

## Application for a Diploma

A formal application for a diploma is placed by the student simultaneously when he or she applies for admission to candidacy (Form GS4). This order is submitted to the Graduate School and **must be resubmitted should the student not graduate on the anticipated date.** A \$25\*\* late fee is assessed a student whose Form GS4 is submitted after the deadline dates, and increases at the rate of \$5\*\* per day thereafter (excluding Saturday, Sunday or University holidays).

## Awarding of Graduate Degrees Posthumously

A graduate student with a grade point ratio of 3.0 or above and plan of study (Form GS2) on file, who has applied for graduation at the end of the semester or summer session and dies during that period or the subsequent semester or summer session, may be awarded the graduate degree posthumously provided the faculty of the college so recommends.

## Academic Regulations

### Permanent Academic Records

The student's permanent academic record is a historical record of the student's academic progress. It is maintained in the Registrar's Office and contains personal identifying information, grades and credits. Where appropriate, statements of a corrective nature, withdrawals, suspension for failure to meet academic standards, suspension for disciplinary reasons and graduation data are added.

\* An academic semester is defined as a minimum of nine credit hours of course work not graded pass/fail. An academic year is defined as the total of two academic semesters.

\*\* Subject to change.



## Academic Standards (Grading)

Most graduate courses are graded on an A-B-C-F scale. Thesis and dissertation research and several other graduate courses are graded on a pass/fail basis. These courses are not included in the academic average; however, the grade is placed on the student's permanent record. Only credit hours for which a grade of pass is achieved apply toward the number of credit hours required for the degree. The accumulation of grades of pass in thesis or dissertation research does not imply completion of the research, but indicates satisfactory progress only.

A minimum grade of C must be made on all course work to obtain graduate credit. The graduate student must maintain a cumulative B average in all graduate-level courses (600 level or above) and in undergraduate courses, excluding those taken on a pass/fail basis. See "Enrollment on a Pass/Fail Basis," page 29. Students who fail to meet these requirements become ineligible for graduation and are placed on academic probation. The probationary status will remain in effect until nine additional semester hours of graduate credit have been attempted. Students who fail to remove the probationary status as prescribed are subject to academic dismissal and will not be permitted to continue in the Graduate School without the recommendation of the program coordinator and written approval of the Graduate School. Withdrawal from a course while on probation will not be allowed unless prior approval is obtained from the Graduate School. Any unauthorized withdrawal will be considered as an unsatisfactory academic performance.

The cumulative B average requirements described above apply independently to graduate degrees sought at Clemson University; that is, the grade point ratio computation begins anew after the student has completed the first degree. However, when a doctoral degree is pursued after completion of a master's degree in the same major, the grade point ratio computation continues for both degrees.

A grade lower than the specified minimum can be raised to count toward an advanced degree only by repetition of the course. Reexamination is not permitted.

A graduate student must understand that he or she can be dropped from the Graduate School at any time for failure to maintain an adequate academic status.

## Final Examinations in Graduate Courses

Graduate course work specifications vary widely between disciplines. Evaluation of graduate work is based upon a number of observations, presentations, tests, papers and/or other measures. The final evaluation includes an examination at the conclusion of the course, which in most cases will be written, but may take on other forms.

## Incomplete Graduate Course Work

Except for courses graded on a pass/fail basis, the grade of incomplete (I) may be given for incomplete work for any graduate course in which work remains unfinished and the student is unable to fulfill all requirements because of circumstances beyond his or her control. This grade is not given in lieu of unsatisfactory or failing grades received for completed courses for the purpose of improving the grade later.

It is the student's responsibility to contact the instructor regarding the work required to complete the course. Upon request by the student, the instructor shall provide a written statement of the work to be completed.

The grade of I will be valid in normal lecture or laboratory courses for only 30 days after the beginning of the next scheduled session, excluding summers and irrespective of the student's enrollment status. Within this period, the student must complete his or her work or obtain an extension, approved by the instructor and head of the department responsible for the course, stating the reason for the request and the length of time needed. Normally, only one request for an extension for each grade of I will be granted.

Students receiving a grade of I in courses such as special problems or other unstructured, independent study courses as designated by the Graduate School must complete all work and receive a final grade within one calendar year. At the discretion of the instructor, the deadline for removal of these incomplete grades may be less than one year. Under rare circumstances, an extension may be granted.

A graduate student will not be permitted to repeat any portion or reregister for any course for which the grade of I has been given, or register in any other course (except GS 799) for the purpose of removing the grade of I. Should any work remain incomplete at the expiration of the appropriate deadlines described in the previous paragraphs, a grade of F will be recorded on the student's permanent record. Although the Graduate School will attempt to bring the deadlines to the attention of the student and instructor, it is the sole responsibility of the graduate student to comply with these regulations.

Students who receive a grade of I while enrolled in the Graduate School at Clemson University remain ineligible for graduation until the incomplete work has been made up and a letter grade submitted to the Office of Admissions and Registration.

Grades of I will have a 10-working-day period after the deadline for the instructor to grade the work and submit the make-up grade card to the Registrar's Office. Work submitted by the student after the printed deadline should not be accepted by the instructor unless an extension has been approved. Requests for extensions, like the make-up work, should be submitted by the deadline printed on the make-up card.

Grades of I that remain after the 10-working-day period will be converted automatically to an F. Changes after that time will be difficult and will require a change of grade form that explains why the grade should be changed. Faculty do not have a right to change a grade under these circumstances. Failure to report final grades for work completed on time or to report an extension constitutes a failure by the faculty to fulfill their obligations to the University.

## Withdrawal from Courses

Withdrawal from graduate course work beyond the first few weeks of class is strongly discouraged, particularly from those courses listed on a student's Form GS2. Withdrawals after the first few weeks of class should only be made for unusual academic reasons or for pressing medical or personal reasons. Students who officially withdraw within the first four weeks of classes will have no grades recorded, while those who officially withdraw after the first four weeks and prior to the last five weeks will have a grade of W (withdrew) entered on the official records. Students may not withdraw within the last five weeks of classes.

Permission to withdraw should be obtained from the faculty advisor on the Schedule Change Form available from the Office of Student Records. If the advisor does not grant permission to withdraw, the student may appeal to the department head. A refusal by the department head may be appealed to the dean of the Graduate School. The date on which the approval form is filed with the registrar is the official date of withdrawal.

The withdrawal dates described above apply to the regular semesters only. Reference should be made to page 2 for the appropriate dates for the summer sessions.

Failure to attend classes or verbal notification to instructors **does not constitute withdrawal**. Students who drop out of a course without officially withdrawing as previously described will be credited with a failure.

## Continuous Enrollment

Although continuous enrollment is not a formal requirement for an advanced degree, graduate students are expected to pursue their degrees with a minimum of interruption. Students who do not remain continuously enrolled (summers excluded) are subject to the requirements in effect at the time of return.



Only students who are enrolled are eligible to use University facilities and human resources and/or receive any form of financial aid. Students who have completed all required work and who find it necessary to be enrolled during a given semester so as to use facilities or human resources may enroll in GS 799 for a minimum of one credit.

### Enrollment Limits

Upper limits on graduate student enrollment per semester refer to graduate and undergraduate credits combined and should be attempted only by the most qualified students.

Student Category	Maximum Credit Hours		
	Semester	6-Week Session	3-Week Session*
Full-Time Students	18	6	3
Graduate Assistants (1/4 time)	15	5	3
Graduate Assistants (1/2 time)	12	4	2
Graduate Assistants (3/4 time)	12	3	1
Persons Employed Full Time	6	3	1

Quarter-time, half-time and three-quarter-time graduate assistants are defined as those who contribute an average of 10, 20 and 30 clock hours per week, respectively, of service to the University for the entire semester. A person employed full time is defined as anyone employed five full working days per week regardless of the employer(s). A graduate student who becomes employed full time while the assistantship is in force must notify the Graduate School and the department providing the assistantship. Graduate students paid solely on an hourly basis are not classified as graduate assistants but are subject to the same limitation in credit loads previously described.

For students whose hours of service per week fall between those defining each student category, the maximum credit load during a regular semester is found by linear interpolation. Any exceptions to the maximum credit loads must be requested by the department and approved in advance by the Graduate School.

### Enrollment on a Pass/Fail Basis

The only graduate courses that may be taken on a pass/fail basis are thesis and dissertation research and a small number of unstructured courses in which the pass/fail grading system appears directly in the course description.

Graduate students shall not enroll on a pass/fail basis or audit any course required by the department or program as an undergraduate deficiency. All other undergraduate courses may be taken on a pass/fail basis. This decision must be made by the last day to add a class and is implemented by the student's major advisor or department head forwarding a request to the Graduate School.

### Auditing by Graduate Students

Permission for a student to audit a particular graduate course is at the discretion of the head of the department or the coordinator of the program offering the course. The principal factors involved in granting permission are that the auditor must possess the necessary academic background and space must be available.

Audited courses do not carry credit, and the fact that a course has been audited is not noted on the graduate student's official record. Graduate auditors are not required to stand tests or examinations. However, the instructor, at his or her own discretion, may demand or deny the auditor's participation in class to whatever extent deemed desirable.

A graduate student may not satisfy by audit a stated prerequisite for a graduate course. Additionally, a graduate student may not establish credit through examination in any course for which he or she was previously registered as an auditor.

### Acceptance of Transfer Credit

A maximum of 12 semester credit hours of work may be transferred from an accredited institution\*\* for the purpose of meeting the requirements for a master's degree. Credits earned in a nondegree status at Clemson University are considered transfer credits because they were earned prior to admission to a degree program. For the doctoral degree, as many as 48 semester credit hours of work may be transferred.

In all cases, the use of transfer credits must be recommended by the student's advisory committee and approved by the department. Under no circumstances will transfer credit be awarded for research, internship or courses graded P/F, or for courses in which a grade lower than B, or its equivalent, has been received. Quality points for courses taken at institutions other than Clemson University will not be included in the student's academic average.

Credits may be transferred for work completed at off-campus centers of accredited institutions provided such courses are acceptable, without reservation, in degree programs at those institutions. No credit will be given for continuing education units, correspondence, extension or in-service courses, or for concentrated courses and workshops that award credits at a rate exceeding one credit per week.

All transfer credits must be verified by an official transcript from the institution at which the work was completed. Course work completed outside the six-year time limit may not be transferred to Clemson University or validated for graduate credit (see "Time Limit" on page 25 for clarification). Valid transfer credits will appear on the student's transcript as credits earned.

It is the student's responsibility to request a transcript of transfer credits to be sent directly to the Graduate School. The degree will not be conferred at the close of the term during which the student has been registered elsewhere for the purpose of transferring credits.

### Independence of Graduate Degrees

The requirements for a graduate degree at Clemson University cannot be met with credits used to satisfy the requirements of another graduate degree earned at Clemson University or elsewhere. Thus, the degrees are independent, implying that the formal curriculum for the degree at Clemson University can contain no credits used for an earlier graduate degree.

### Appeals and Grievances

The Commission on Graduate Studies hears appeals regarding admission, degree requirements or other policy decisions affecting the welfare of graduate students. The appeal must be presented in writing to the dean of the Graduate School or to members of the commission.

The committee is comprised of five members as follows: (a) two members of the faculty appointed for two-year staggered terms by the respective college dean in collegiate rotation; (b) two graduate students, representing two colleges other than those represented by the faculty, nominated and approved by the Graduate Student Association and appointed by the provost for one-year terms; and (c) the dean or associate dean of the Graduate School (or the dean's designee). The chairperson is the faculty member in the senior year of service on the committee.

The Graduate Student Grievance Committee hears all grievances involving the following: (a) grievances of a personal or professional nature involving an individual student and a faculty member; (b) the claim by a student that the final grade in a course was inequitably awarded; (c) cases where the grievance involves graduate student employment; and (d) graduate student academic dishonesty. In all unresolved cases the committee makes its rec-

\* Should the six-week and three-week sessions run concurrently, the total credits are not permitted to exceed the upper limit for the six-week session.

\*\* Refers to accreditation by one of the six regional Associations of Colleges



ommendations to the president through the provost. All proceedings of the committee are confidential.

In cases involving academic dishonesty, the Policy on Academic Dishonesty below shall be applied, and the grievance shall be filed within seven days from the date a written charge is made by the professor. A copy of the charge is to be given to the department head or dean. In cases involving a protest of a final grade, the grievance must be filed within 120 calendar days from the date printed on the grade report for the term in which the student alleged an inequitable grade was recorded.

Rules and procedures for the filing and hearing of grievances are as follows:

1. Any complaint should first be taken to the faculty or staff member involved for resolution. If no resolution is reached, the graduate student should consult with the department head and the dean or the immediate superior of the staff member to hear the grievance and act as a referee. The student, dean of the college, department, and faculty or staff member should make every effort to reach a solution.

2. If the grievance remains unresolved, the student may bring it before the Graduate Student Grievance Committee by a written statement detailing the grievance. All issues to be grieved must be delineated in the written statement. The statement must be delivered in a sealed envelope to the Office of the Dean of the Graduate School within 60 calendar days of the date the graduate student alleges to have been aggrieved, except in cases involving a protest of a final grade when the statement must be filed within 120 calendar days from the date on the grade report. The dean of the Graduate School (or the dean's designee) shall attempt to resolve the grievance. If no resolution is reached, then the dean of the Graduate School (or the dean's designee) shall advise the graduate student in assembling the necessary information for presenting his or her complaint to the Graduate Student Grievance Committee. The dean will forward this letter to the chairperson of the Graduate Student Grievance Committee. Failure of the student to file a grievance within the 60-day time period will result in forfeiture of the right to file a grievance under this procedure.

3. The committee will attempt to gather all pertinent information in separate meetings with all individuals able to give information concerning the grievance.

4. The Graduate Student Grievance Committee will, if at all possible, handle each case as a confidential matter.

5. The committee will formulate its findings in writing and seek to obtain signed approval for the recommended solution from all parties involved.

6. If the committee cannot obtain a solution that is acceptable to all involved parties, the committee will provide an opportunity for a hearing on the grievance. Two weeks' notice will be provided to all parties in the grievance. Either party to the grievance may petition for a hearing on the grievance.

7. The hearing on the grievance will be informal and closed to the public. The chairperson of the committee shall take whatever action is necessary to ensure an equitable, orderly and expeditious hearing. Minutes of the meeting will be taken, and all parties to the grievance will be given an opportunity to be heard. Each party is responsible for having present at the hearing all witnesses who will speak on his or her behalf. In addition, the chairperson may request the presence at the hearing of any other person who has pertinent information on the grievance.

Witnesses shall not be present during the hearing proceedings except when called upon to speak before the committee. The parties will be permitted to question all individuals present at the hearing and heard by the committee. If any witness is unable to be present at the hearing, the chairperson may, at his or her discretion, accept a written statement from that witness to be presented at the hearing. The parties shall be accorded the right to assistance

of counsel of their own choice; however, the role of counsel shall be solely to assist the party, and counsel shall not be permitted to participate actively in the proceedings.

8. Upon conclusion of the hearing, the committee, meeting in executive session, shall reach, by a majority vote of those committee members present, a solution to the grievance. If the chairperson can persuade all parties to the grievance to accept the committee's solution, the matter of the grievance will be considered closed when the solution is effected.

9. If, after the conclusion of the hearing, the chairperson cannot obtain approval of the committee's recommended solution from all involved parties, the grievance will be referred to the president of the University via the provost, with the committee's solution as the recommended solution to the grievance. When grievances are referred in this manner, the president shall make the final decision on behalf of the University.

10. The Graduate School shall keep in confidence all records pertinent to each grievance and pass these records to the Office of the Provost for filing. Records shall be available to succeeding chairpersons of the Graduate Student Grievance Committee.

11. A majority of committee members shall constitute a quorum for transaction of committee business; at least one appointed faculty member and one appointed graduate student must be present.

12. The Graduate Student Grievance Committee shall meet as often as necessary to dispense expeditiously with grievances brought before the committee.

13. These rules and procedures can be amended by the Commission on Graduate Studies. Such rule changes will not affect any case under consideration at the time of the change. Notification of any amendments to these rules and procedures should be given to the president of the University via the Academic Council.

## Policy on Academic Dishonesty

### I. General

- A. Academic dishonesty includes giving, receiving or using unauthorized aid on any academic work.
- B. Plagiarism, a form of academic dishonesty, includes the copying of language, structure or ideas of another and attributing the work to one's own efforts.
- C. All academic work submitted for grading contains an implicit pledge and may contain, at the request of the instructor, an explicit pledge by the student that no unauthorized aid has been received.
- D. Academic dishonesty includes attempts to copy, edit or delete computer files that belong to another person or use Computer Center account numbers that belong to another person without the permission of the file owner, account number owner or file number.

### II. Penalties

- A. A student guilty of the first offense of academic dishonesty typically will receive a grade of F for the course. In flagrant cases, the student may also be suspended for one or more semesters or may be permanently dismissed.
- B. A student guilty of the second offense of academic dishonesty will receive a grade of F for the course, will be suspended for one or more semesters and may be permanently dismissed. Suspension and dismissal require approval of the president of the University.



### III. Procedure

- A. Academic honesty is the individual responsibility of each student. Students should report violations of this policy either to the instructor of the affected course or to any member of the administration.
- B. When, in the opinion of an instructor, a student has committed an act of academic dishonesty, the following procedure must be followed:
  1. The instructor will inform the student in private of the nature of the alleged charge of academic dishonesty and will simultaneously request in writing that the department chair verify from the registrar the incident's being a first offense.
  2. When this information has been received, the instructor will notify the student in writing of the charge of academic dishonesty and the penalty recommended by the instructor and approved by the chair of the department in which the course is taught. The notification will further state that if the student regards the charge as unfair, the student has seven days from the date of receipt of notice to file a grievance with the Graduate Student Grievance Committee.
  3. If no grievance is filed by the student, the instructor will forward copies of the written notification to the dean of the college and to the registrar.
  4. Should the act of dishonesty not be in the college of the student's major, the registrar will notify the major department chair.
  5. A charge of academic dishonesty in a course must be made within 45 calendar days of the date printed on the grade report for the semester or session in which the course is completed. For grades that replace an original grade of I (incomplete), the 45 days begin the day the I is converted to the final grade.

### Grade Protests

A student wishing to protest a course grade must first attempt to resolve any disagreement with the instructor. In failing to reach a satisfactory resolution, the student may follow the procedure under "Appeals and Grievances" (page 29). All grade changes and grievances must be filed within 120 calendar days from the date on the grade report.

### Policy on Sexual Harassment

Title VII of the Civil Rights Act of 1964, as amended, provides that it shall be unlawful discriminatory practice for any employer, because of the sex of any person, to discharge without just cause, to refuse to hire, or otherwise discriminate against any person with respect to any matter directly or indirectly related to employment. Harassment of any employee on the basis of sex violates this federal law. The Equal Employment Opportunity Commission has issued guidelines as to what constitutes sexual harassment of an employee under Title VII.

Unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature constitute sexual harassment when the following occurs:

1. submission to such conduct is made explicitly or implicitly a term or condition of an individual's employment or academic standing; or
2. submission to or rejection of such conduct by an individual is used as a basis for employment or for arriving at academic decisions affecting an individual; or
3. such conduct unreasonably interferes with an individual's work or academic performance, or creates an intimidating, hostile, or offensive working or academic environment.

Sexual harassment of University faculty, staff or students is prohibited and shall subject the offender to dismissal or other sanctions after compliance with procedural due process requirements. In the event a claim of sexual harassment arises, the claimant may use University grievance procedures that have been established for faculty, staff and students as appropriate. This policy also prohibits an employee from sexually harassing a superior and a student from sexually harassing a faculty member. Employees or students who feel they are victims of this form of discrimination are encouraged to consult the Office of Access and Equity, E-103 Martin Hall, 656-3181, for advice and assistance in resolving complaints.

### Academic Research

#### Policy on Research Ethics

##### I. Preamble

Research institutions have a critical responsibility to provide an environment that promotes integrity, while at the same time encouraging openness and creativity among scholars. Care must be taken to ensure that honest error and ambiguities of interpretation of scholarly activities are distinguishable from outright misconduct. To address all allegations of fraud or misconduct, definitions, policies and procedures must be in place to facilitate and guide such processes.

##### II. Definitions

###### A. Research

Research is used in a general sense (as opposed to scientific research) to yield a policy applicable to all academic disciplines in the University.

###### B. Misconduct

Dishonest deviation from accepted practices in conducting research activities.

Fraudulent failure to comply with university, regulatory and funding agencies requirements affecting specific aspects of the conduct of research.

This definition includes:

Falsification of data — ranging from falsification or intentional misrepresentation of methods, materials or results to selective reporting of findings, such as the purposeful omission of conflicting data with the intent to manipulate the results;

Plagiarism — representation of borrowed work as one's own;

Misappropriation of others' ideas — the unauthorized and intentionally dishonest use of privileged information (such as that which might be gained during peer, paper or grant reviews), however obtained;

Malicious and public misrepresentation of a colleague's ethical research behavior;

Conflicts of interest that could influence the researcher's decisions or conclusions, or which could provide unfair gain to the researcher;

Other misuse of position as researcher for personal gain;

Exploitation (such as failure to credit work, misrepresentation of a research relationship, etc.) of students, or other persons, for research purposes.

This definition does not include:

Non-fraudulent failure or inadequacy of performance, incompetence or honest error;

Non-fraudulent breaches of contracts;



Employment discrimination, sexual harassment, violation of human subjects policy or animal welfare policy, or other forms of misconduct that are the concerns of different, distinctive administrative policies.

### C. Inquiry

Expeditious gathering and review of information to determine if an investigation is warranted.

This is not a formal hearing, but a process designed to separate frivolous, unjustified or mistaken allegation from facts regarding the incident.

### D. Investigation

A formal examination and evaluation of all relevant facts to determine if an instance of misconduct has occurred.

### E. Disposition

The Committee of Investigation shall only determine whether a breach of ethics has occurred and will not make recommendations relative to the nature or severity of the action to be taken.

If the investigation committee finds that the complaint was intentionally dishonest and malicious, the committee can recommend action against the accuser.

In the event that allegations are not confirmed, the institution shall make full efforts to restore the reputation of the accused; the accused's recommendations to accomplish this should be accommodated insofar as is possible.

## III. Procedure

### A. Overall Structure

An allegation or complaint involving the possibility of misconduct can be raised by anyone. The allegation should be made in writing to the Faculty Senate president in a confidential manner. Accusations must be signed.

Charges must be filed within seven years of the date on which the event in question occurred. If the date of limitation is in question, the Faculty Senate president, the chair of the Faculty Senate Research Committee and the vice president for research shall determine whether the given event occurred within the specified time limit.

The Faculty Senate president and the chair of the Faculty Senate Research Committee should accept the accusation only after they are satisfied that its substance complies with this policy's definition of "misconduct." At this time, and at their discretion, they may consult with the vice president for research relative to the alleged research ethics violation.

A meeting should be scheduled to occur within 20 calendar days following acceptance of the accusation for the accused to appear before the president of the Faculty Senate and the chair of the Faculty Senate Research Committee for the purpose of hearing the charge(s) and being informed of who authored the charges. The accused will be asked to plead "guilty" or "not guilty" to each charge. If the accused pleads "guilty," the president of the Faculty Senate will report the facts to the vice president for research, who will, within 90 calendar days, prepare a report for the provost.

If the accused pleads "not guilty," or if the accused refuses to respond, an inquiry, the first step of the review process, should result. The vice president for research should be notified of the inquiry. In the inquiry state, factual information is gathered and expeditiously reviewed to determine if an investigation of the charge is warranted. An inquiry is not a formal hearing; it is designed to separate allegations deserving of further investigation from frivolous, unjustified or clearly mistaken allegation.

The vice president for research will inform the accuser of the disposition at the conclusion of the investigation stage.

During the initial meeting with the accused for the purpose of presenting charges, only the Faculty Senate president, the chair of the Faculty Senate Research Committee and the accused with his/her lawyer, if desired, may be present. During hearings by the Committee of Inquiry or the Committee of Investigation, only duly appointed members of the given committee and the committee's invited witnesses with his/her lawyer, if desired, may be present.

### B. Inquiry

The vice president for research and the Faculty Senate president will appoint, within 10 calendar days of a response of "not guilty" to charges by the accused, a Committee of Inquiry of three faculty members with one individual appointed as chair.

For any specific allegation or set of allegations, the Committee of Inquiry will determine if an investigation is warranted. The Committee of Inquiry will submit a written report to the vice president for research and the Faculty Senate president within 30 calendar days of the formation of the Committee of Inquiry.

### C. Investigation

If the Committee of Inquiry so recommends, the vice president for research and the Faculty Senate president will appoint within 20 calendar days a Committee of Investigation consisting of five faculty members, other than those serving on the Committee of Inquiry, to conduct a full investigation.

The Committee of Investigation, meeting in closed sessions, will review all materials, question relevant parties, and allow for all parties to present their views separately (without the presence of the other parties) to the committee.

The Committee of Investigation will prepare, within 90 calendar days, a report indicating whether ethics violations have occurred; the report may include estimation of one or more of the following:

- the scope of the intentional dishonesty perpetrated by the accused;
- the degree of gain that might accrue to the accused because of the unethical behavior;
- the seriousness of harm intentionally perpetrated against other individuals.

The estimation shall be used in determining disciplinary action against the accused. In less serious cases, action may include a verbal reprimand, or, if conditions warrant, a letter in the offender's personal file. In more serious cases, action might include such sanctions as additional supervision of research activity, loss of merit pay or recommendation against promotion. In only the most serious cases should dismissal be considered.

The report will be submitted to the vice president for research and the Faculty Senate president, who will forward the report to the provost.

The provost will review the report and render a decision within 15 calendar days. Any recommendation that may constitute disciplinary action against a faculty member will be referred by the provost to the appropriate dean or other administrator as determined by the provost. The dean or administrator will decide the appropriate action within 15 calendar days.

If disciplinary action taken against a faculty member constitutes a grievable action under either Faculty Grievance Procedure I or Faculty Grievance Procedure II, the faculty member may file a grievance in accordance with the appro-



appropriate procedure. Disciplinary action against other individuals associated with the University are subject to applicable grievance procedures.

#### D. Guiding Principles

Maximize confidentiality and protect the reputations for both the accused and accuser during the full process.

Assure the respondent a fair hearing and access to reports.

Minimize the number of individuals involved in the inquiry and investigation phases.

Individuals chosen to assist in the inquiry process should have no real or apparent conflicts of interest bearing on the case in question. They should be unbiased and have appropriate background for judging the issues being raised.

Consultation of University legal counsel is probably necessary.

Appropriate funding agencies should be fully informed in writing at both the outset and conclusion of an investigation.

All detailed documentation of the committees of Inquiry and Investigation shall be maintained by the Office of the Vice President for Research for at least three (3) years and must, upon request, be provided to authorized personnel.

Appropriate interim administrative actions will be taken by the vice president for research at the outset of the inquiry stage to protect supporting funds and to ensure that the purposes of the project are being met.

#### Executive Interpretation

##### Definitions

II. B. The Research Ethics Policy clearly restricts action to matters of research ethics; it does not address such things as simple ineptitude, non-fraudulent breach of contract or malpractice covered by existing policy (see exclusions under section II). Note the following:

The definition includes malicious and public (suggesting that neither maliciousness nor publicness, alone, is sufficient) misuse of the research ethics policy itself (reference section II. E.).

Exploitation of others includes misuse of colleagues, such as intentional and malicious failure to credit the work of another, deliberately misleading other individuals to obtain research goals, etc. It does not include benign activity that seems to, or may actually, exploit.

This policy should not be construed to include any activity that is benign in intent (not malicious, deliberately misleading, etc.).

II. E. It is the responsibility of University faculty to protect its research integrity by condemning unethical research activity, by investigating credible charges of unethical research brought against the faculty's peers, by taking steps to restore the reputations of peers that are charged unjustly or in error, by assessing the damage done by an unethical peer if appropriate (see section III. C.), and by seeking sanction through University administrative authorities against those who violate ethical research practices. Appropriate administrative personnel alone have the authority to deprive one of property or liberty interests (within legal constraints). Consequently we feel that the assessment and pursuit of sanctions against an individual should not be a matter addressed by this policy.

III. A. Charges which do not fall within the purview of this policy (see section II. B.) should not be forwarded to a Committee of Inquiry. The processes of Inquiry and Investigation threaten an academician's most cherished professional possession — his or

her reputation. That reputation should not be threatened without clear cause, thus charges that do not involve "Research Ethics" as defined by this document should be pursued through other channels. For these reasons, the president of the Faculty Senate and the chair of the Faculty Senate Research Committee, upon receipt of the charges, should confirm that the charges comply in substance with this policy's definitions before any action is initiated. This is not to say that the president of the Faculty Senate and the chair of the Faculty Senate Research Committee should judge the legitimacy of the charges or the facts of the case.

Because the vice president for research has an overall view of University policy and activities that may be valuable at this stage of the process, the president of the Faculty Senate and the chair of the Faculty Senate Research Committee, at their discretion, may consult with the vice president for research prior to rendering a decision about whether the charges should go forward under this policy.

It is in the interest of the accused and the University to provide an opportunity to the accused to abbreviate the procedures outlined in this policy. Specifically, the accused need not be subjected to the trauma of a peer investigation if indeed he or she would prefer to admit guilt and be subjected to appropriate administrative sanction.

III. B. A Committee of Inquiry is responsible for determining whether the facts in the case are contentious (sufficient uncertainty exists to prevent a determination of innocence without extensive investigation), or that there is a probability that the accused's position is or is not credible.

A driving concern of the Committee of Inquiry is the protection of all involved and particularly that of the accused. Toward this end, a Committee of Inquiry should balance the need for information upon which to make a decision against the need for confidentiality, with the balance in favor of confidentiality. The merit of charges cannot always be made on the strength of charges alone, thus, to adequately protect the accused against a potentially damaging investigation, the committee may need to expand its inquiry beyond the charges and accompanying documentation. At the same time, it must be realized that the likelihood of trauma and damage to reputation increases as the scope of an inquiry grows. The pertinent question is, how far should a Committee of Inquiry go to protect an unjustly charged individual against a more extensive investigation given the need to limit the scope of knowledge about the charges? The answer is that the Committee of Inquiry should limit its efforts to the minimum needed to establish that the facts in the case are contentious, or that there is a probability that the accused's position is or is not credible. Certainly the accused should have the opportunity to respond to the charges before the Committee of Inquiry. The Committee of Inquiry may need to seek clarification from the accuser and may even need to resolve doubts by seeking evidence from another source. At all times, however, the Committee of Inquiry should seek to confine the extent of knowledge about the charges leveled, and consequently should cease its inquiry as soon as it can conclude that the charges may or may not be grounded (not that the charges are or are not true). Strategies may include strictly limiting the number of individuals approached about the matter, limiting witnesses to individuals who have prior knowledge of the charges, or soliciting documentation from involved parties.

In addition to determining probability of ethics violation, the Committee of Inquiry should clarify the charges brought against the accused. This involves throwing out charges that are frivolous or ungrounded, and identifying those charges that may be grounded. A subsequent Committee of Investigation, because its investigation is more thorough, need not, of necessity, be bound to the scope defined by the Committee of Inquiry, but should give credence to its recommendations.



III. C. The Committee of Investigation is responsible for determining whether an ethics violation has occurred relative to the situation addressed by the charges. Such violation need not be limited to the specific charges, but should be related to the incidents addressed by those charges. The person who brings charges may be aware of only some of the ethical violations associated with a given incident, thus an investigation needs the freedom to note problems relative to that incident which it may uncover during the course of investigating the charges.

The Committee of Investigation, like its predecessor, is concerned with protecting the integrity of the parties involved. Consequently, it too should balance the need for information upon which to make a decision against the need for confidentiality. In this case, however, the balance should favor the gathering of information. It is important that this committee be correct in its decision than it is to limit the scope of knowledge about the investigation. The committee should, of course, cease operation when it has enough information to make a just decision, but should not jeopardize justice in the name of confidentiality.

### Theses and Dissertations

Candidates for advanced degrees receive academic credit for conducting research and preparing a thesis (master's candidates) or a dissertation (doctoral candidates) under the direction of the research advisor. In those Master of Arts or Master of Science degree curricula requiring a thesis, six credits of research (891) are required. The thesis option curricula in the Master of Architecture, Master of City and Regional Planning, and Master of Fine Arts degree programs require 15, 6-9 and 15 credits of research, respectively. A dissertation, mandatory for all candidates for the Ph.D. or Ed.D. degrees, requires 18 credits of doctoral research (991) exclusive of any research credits earned at the master's level.

The accumulation of grades of pass in thesis or dissertation research does not imply completion of the research, but only indicates satisfactory progress.

1. *Student Responsibility.* The student, in consultation with his or her major advisor, shall provide each remaining advisory committee member with a copy of the manuscript for initial review. This action should take place well in advance of, and not less than three weeks prior to, the final examination and defense of the thesis or dissertation. Students must prepare the manuscript in a style acceptable to the Graduate School; a Guide for the Preparation of Theses and Dissertations may be obtained from the Union Copy Center at a cost of \$4.25\* per copy. When the manuscript is in suitable form, the thesis or dissertation is presented to the Graduate School for review and approval prior to duplication.

Three copies of the thesis or dissertation, required for hard binding, must be submitted to the Graduate School by the deadline date appropriate for the anticipated graduation date. A binding fee of \$24\* must be paid to the bursar and the completed forms returned to the Graduate School at the time the duplicated theses or dissertations are submitted. If the student desires, two personal copies may be bound at a cost of \$8\* per copy; additional copies may be bound at a cost of \$10\* per copy.

For doctoral candidates, a fourth copy of the dissertation is required for microfilming and is placed by the Graduate School with University Microfilms, Inc. of Ann Arbor, Michigan. An additional copy of the approval page, title page and abstract must also be submitted, with the abstract not exceeding 350 words. Occasionally, this will necessitate revision of the longer original abstract, which is retained in all copies. The abstract should be written and edited in a form suitable for publication and data base retrieval. The total microfilming fee is \$50\* and must be paid to the bursar simultaneously with the binding fees. A fee of \$35\* is necessary if copyright is desired.

2. *Faculty Responsibility.* The research advisor determines when the manuscript is suitable for initial review by the remaining committee members. Guidelines for the review process and a thesis/dissertation review form are available in the departments and the Graduate School. These guidelines are designed to produce a timely review by each committee member and to provide a measure of protection for all affected parties against problems resulting from lack of communication and/or attention. If the student requests, the research advisor is obligated to initiate the thesis/dissertation review form and forward it to the remaining committee members along with the manuscript. The research advisor must be cognizant also of departmental practices regarding the quality of the manuscript at the various review stages and of the wishes of the department head, as an ex-officio committee member, to exercise the option of approving the thesis or dissertation in its final form.

Committee members should normally complete the initial review in three weeks or less. Provisions of the guidelines; however, allow for additional time if necessary. Failure of a committee member to complete the initial review within six weeks may result in his or her replacement, provided the student has requested use of the thesis/dissertation review form. A second review after revisions should be completed in one week, with provisions being available for additional time.

It should be understood that a vote to pass a student on his or her performance at the final examination (Form GS7) does not imply final approval of the thesis or dissertation. Approval of the thesis or dissertation is given by signing the approval page.

### Restrictions on Use of Theses and Dissertations

Unpublished theses and dissertations submitted to the Graduate School in partial fulfillment of the requirements for graduate degrees and deposited in the University library are, as a rule, open to the public for reference purposes. However, extended quotations or summaries may be published only with the permission of the author and the graduate dean.

### Publication Policy

A university's primary function is the accumulation and dissemination of knowledge. It is therefore expected that the results of research performed using University facilities be published in the open literature (i.e., theses, dissertations, journals, magazines or books) and that any information obtained may be freely disclosed by the faculty in the teaching programs of the University.

Exceptional cases may arise; however, and the guidelines below shall apply to any sponsored projects requiring that results be kept confidential.

1. The University shall not accept awards that require research results to be kept confidential forever. A definite term of confidentiality shall be stated in a written nondisclosure agreement and shall not exceed one year beyond the date of notification to the sponsor that a manuscript suitable for publication has been prepared. Exceptions may be granted by the University administration only under unusual circumstances; e.g., national security, national emergency, classified activities or certain confidential agreements.

2. Students associated with confidential projects must have prior approval for the use of results in preparing reports, theses or dissertations in fulfillment of degree requirements. The Graduate School will normally not accept a thesis or dissertation that must be held in confidence for more than one year. Documents submitted in partial fulfillment of degree requirements will be retained by the Graduate School (or the department in the case of project reports for nonthesis programs) in accordance with the nondisclosure agreement. The student's thesis or dissertation defense shall not be open to those not bound by the nondisclosure agreement.

\* Subject to change.



## Patents and Copyrights

All students enrolling in the Graduate School at Clemson University do so with full understanding that:

1. The University has full ownership rights in any inventions, discoveries, developments and/or improvements, whether or not patentable (inventions), which are conceived, developed or reduced to practice, or caused to be conceived, developed or reduced to practice, by graduate students during the course of their research activities conducted as part of any Graduate School curriculum. Any such invention will be handled by the University in the same manner as set forth in *The Faculty Manual of Clemson University*, the pertinent provision for which appears as Part VI E entitled "Patent Policy."

2. Copyright ownership of any research work will be determined by University policy and by policies of organizations responsible for publishing or distributing copyrighted materials.

Copies of the policies on patents and copyrights are available in the individual departments and colleges and in the Graduate School. Any graduate student who plans to accept a research assistantship or public service assistantship is encouraged to read the policies prior to accepting the assistantship.

## Scientific Research

Graduate students conducting scientific research in a student role at Clemson University do so with the full understanding of the following:

1. At the discretion of their employment supervisor, students may be required, at the initiation of the research efforts, to maintain and preserve all primary data and materials associated with the research, and deliver these materials to their supervisor in complete, cataloged and identified form before the students will have been deemed to have completed the requirements for their program of study. Once delivered, these materials may be disposed of at the discretion of the department.

2. At the discretion of their employment supervisor, students may be required to keep a clear, concise and complete research notebook(s) as an accurate record of their research activities and deliver these notebooks to their supervisor before they will have been deemed to have completed the requirements for their program of study. Once delivered, the notebook(s) may be disposed of at the discretion of the department.

## DEGREE REQUIREMENTS

Courses are offered leading to the research degrees of Master of Arts, Master of Science and Doctor of Philosophy.

In addition, courses are offered leading to the professional degrees of Doctor of Education, Specialist in Education, Master of Agricultural Education, Master of Agriculture, Master of Architecture, Master of Business Administration, Master of City and Regional Planning, Master of Construction Science and Management, Master of Education, Master of Engineering, Master of Fine Arts, Master of Forest Resources, Master of Health Administration, Master of Human Resource Development, Master of Industrial Education, Master of Parks, Recreation and Tourism Management, Master of Professional Accountancy and Master of Public Administration.

### Master's Degree

#### Course Work

The total number of graduate credits required for the degree is determined by the student's advisory committee, consistent with the specific program guidelines and Graduate School policy. These credits constitute the core of the student's Graduate Degree Curriculum (Form GS2) and appear on the form at the location entitled REQUIRED COURSES (GRADUATE LEVEL ONLY).

Undergraduate deficiencies are listed at the designated location. Supplemental courses, carrying undergraduate or graduate credit and chosen to broaden the student's academic experience, are not required on Form GS2. However, if a listing is desirable, such courses will be listed as departmental requirements at the designated location.

The Graduate School requires each degree program to consist of a minimum of 30 semester hours of graduate credit with at least 12 semester hours, exclusive of thesis credit, in the major discipline as defined by the advisory committee, subject to degree program regulations. A minor outside that degree program, if chosen, shall consist of at least six semester hours in that area. The following conditions, appropriate for the types of degrees, must also be observed:

1. *Master of Arts or Master of Science (Thesis Option)*. Each program includes a minimum of 24 semester hours of graduate credit exclusive of thesis research and six semester hours of thesis research (891). At least one-half of the total graduate credit hours required by the advisory committee, exclusive of thesis research, must be selected from courses numbered 800 or above.

2. *Master of Arts or Master of Science (Nonthesis Option)*. Each program includes a minimum of 30 semester hours of graduate credit, none of which may be thesis research. At least one-half of the total graduate credit hours required by the advisory committee must be selected from courses numbered 800 or above.

3. *Professional Master's Degrees*. Each program includes a minimum of 30 semester hours of graduate credit. Except for professional programs in the College of Architecture, Arts and Humanities which require a thesis, research credits (891 or 991) may not be included in the program requirements. At least one-half of the total graduate credit hours required by the advisory committee must be selected from courses numbered 700 or above. Any additional requirements for these degrees are described under the colleges which offer the degrees.

### Residence

There is no University-wide residence requirement for a master's degree. However, individual degree programs may establish a requirement, which will be described and publicized for all prospective master's degree candidates in the particular program.

### Time Limit

All course work to be credited toward any master's degree must have been enrolled in and completed within six calendar years prior to the date on which the degree is to be awarded. For example, a person graduating in the spring semester must have started and completed all course work within the 72-month period beginning with the summer term six years earlier. When recommended by the student's advisory committee and approved by the graduate dean, as many as six semester hours of course work at Clemson University completed outside the six-year limit may be validated by a **written** comprehensive examination based on the latest syllabus and course content. Such examinations will be under the direction of the department regularly offering the course or courses for which the student seeks validation. Independent study courses are not subject to validation. Course work completed outside the six-year time limit at an institution other than Clemson University may not be transferred to Clemson or validated for graduate credit.

### Foreign Language

A reading knowledge of one approved foreign language is a departmental requirement for certain Master of Arts and Master of Science degrees. The language level expected is a basic reading knowledge equivalent to that provided by two years of study at the college level. The requirement may be satisfied by passing



a translation test administered by the Department of Languages or by passing a test similar to that given as the final examination of a language course designed for graduate students.

The Department of Languages will administer the foreign language translation test four times annually: on the first Thursdays of November and March and once during the final examination period of each summer session. The student will be assessed no fee for the first test administration. A fee of \$20\* will be assessed for the second and any subsequent administrations. Applications, available in the Department of Languages, must be filed with the Department of Languages at least three weeks before the test date.

On the recommendation of the chair of the Department of Languages, a student may satisfy the requirement by having completed at least 12 semester credit hours in an approved foreign language with an average grade of B or better. These credit hours must be earned from an accredited baccalaureate institution and must have been completed in total within six years prior to the student's finishing the graduate degree. The chair of the Department of Languages may recommend a waiver of the minimum grade and six-year limitation for any student who can substantiate extensive additional training in a foreign language.

### Off-campus Research

Although thesis research is normally performed at Clemson University, it is recognized that Clemson University may not have on its campus certain specialized equipment or facilities that would be desirable for advanced training at the master's level. Thus, for those cases in which thesis or other advanced study is required and the facilities to pursue such study are not available on the Clemson campus, permission may be granted for off-campus research. The requirements to be satisfied in such cases are identical to those listed for the doctoral degree under "Off-campus Research" on page 37, with the exception that the off-campus research supervisor need not hold the Ph.D. degree, provided he or she is qualified and certified for the supervisory position by the department and college involved and by the graduate dean.

### Final Examination

Each candidate for the master's degree, after completion of the thesis, if required, and at least three weeks before the degree is to be awarded, must pass a final examination. The examination may be oral and/or written, and is administered by the advisory committee or a standing committee appointed in accordance with published program policies. The purpose of the examination is to ascertain the general knowledge of the candidates with particular reference to the major and minor subjects and the thesis or departmental report. The Graduate School will be notified of the time and place of the examination at least 10 days prior to the time scheduled. Members of the faculty, as well as members of the Graduate Curriculum Committee and the dean of the Graduate School, are invited to attend the examination. Within three days after the examination, the examining committee, through Form GS7, will notify the Graduate School of the results of the examination. A student who fails a final examination may be allowed a second opportunity only with the recommendation of the advisory committee. Failure of the second examination will result in dismissal from the Graduate School.

### Specialist in Education Degree

The degree requirements for professional master's degrees and the requirements pertaining to residence, time limits and final examinations for master's degrees also apply to the Specialist in Education degree. Course work required includes 30 semester hours beyond the master's degree to be selected from five areas prescribed by the Department of Elementary and Secondary Education.

## Doctor of Philosophy Degree

### Course Work

Work leading to the Doctor of Philosophy degree is planned to give the student a comprehensive knowledge of his or her field of specialization and a mastery of the methods of research. The degree is not awarded solely on the basis of course work completed, residence or other routine requirements. The final basis of granting the degree is the student's grasp of the subject matter of a broad field of study, competency to plan and conduct research, and ability to express himself or herself adequately and professionally in oral and written language.

The advisory committee aids the student in developing a graduate degree curriculum, which includes the selection of specific courses and their sequence. Although no minimum course work requirements exist for the doctoral degree, committees are encouraged to require courses other than those that directly support the dissertation research. Work in the minor field or fields, if required, normally comprises from 12 to 24 hours in courses carrying graduate credit. A minimum of 18 hours of doctoral research is required. Should the direction of study or research interest change, the student may request the appointment of a new advisor.

### Residence

Residence is a necessary concept in graduate education, particularly in the preparation of the dissertation. The purpose of residence is to require the student to spend a specified minimum amount of time as follows:

1. in direct personal association with members of the faculty of the University;
2. under direct tutelage and advisement of a research advisor and advisory committee in the department or program of the major; and
3. participating in other normal activities pertinent to graduate education such as seminars and close association with other student researchers.

To receive the Doctor of Philosophy degree, the student must complete at least 15 semester hours of graduate credit including research credit hours (991) on the Clemson University campus in a continuous 12-month period.

For students employed substantially more than half time, a statement specifying the manner in which the residence requirement is to be satisfied shall be formulated by the advisory committee and be included in the graduate degree curriculum. Also, upon completion of the final examination, the student's committee will forward to the Graduate School a statement approved by the department head and college dean certifying that residence requirements have been met.

### Time Limit

Because no minimum course work requirements exist for the Doctor of Philosophy degree, the time limitation for completion is determined by the dates by which essential ingredients of the degree are completed. The following must be passed in the five-year period prior to graduation:

1. comprehensive examination (see page 37),
2. foreign language examination, if required by program (see below),
3. defense of dissertation (see page 38), and
4. approval of dissertation by the Graduate School (see page 34).

\* Subject to change.



## Foreign Language

Certain doctoral programs include a foreign language requirement. Languages accepted by all departments are French and German. Under certain conditions, Spanish, Russian or the classical languages may be accepted. Upon the recommendation of the head of the Department of Languages, use of other languages may be approved, provided adequate justification can be presented, the language is not native to the student and a proper testing procedure can be established. Any expense incurred in obtaining assistance for such testing must be paid by the student.

The language level expected is a basic reading knowledge equivalent to that provided by two years of study at the college level. The requirement may be satisfied by passing a translation test administered by the Department of Languages or by passing a test similar to that given as the final examination of a language course designed for graduate students.

The Department of Languages will administer the foreign language translation test four times annually: on the first Thursdays of November and March and once during the final examination period of each summer session. The student will be assessed no fee for the first test administration. A fee of \$20\* will be assessed for the second and any subsequent administrations. Applications, available in the Department of Languages, must be filed with the Department of Languages at least three weeks before the test date.

The foreign language requirement must be satisfied in a five-year period prior to the awarding of the doctoral degree and prior to admission to candidacy for the degree.

## Off-campus Research

Under special circumstances, it may appear desirable that doctoral research be conducted away from the Clemson University campus. If such research is to be performed under the immediate direction of a Clemson University faculty member acting as dissertation advisor and supervisor, then in order to accommodate the student as well as to exercise proper and necessary control over this most important phase of doctoral study, the following additional requirements will be made:

1. *Written Consent and Research Plan.* The student must have the written consent of his or her dissertation advisor, full advisory committee, department head, college dean and the graduate dean. Prior to departure from campus, the student must submit a written plan for his or her research effort to the advisory committee for approval. The plan should include a discussion of the problem and intended scope of the investigation, and should be structured in terms of a specific time frame.

2. *Statement from Organization where Research Will Be Conducted.* The advisory committee may require a statement from an appropriate officer of the organization at which the student will be located agreeing to (a) the student's plan to complete dissertation research using the organization's equipment and facilities; (b) the apportioning of at least 25 percent or other appropriate amount of the student's employment hours to dissertation research; and (c) the organization's release of patent rights or copyrights arising from discoveries or concepts that evolve during the course of the student's doctoral research.

3. *Travel.* The student may be required to travel to Clemson University, not at the expense of Clemson University, to meet with the dissertation advisor and advisory committee as often as is deemed necessary by the committee. Further, the student may, at the discretion of the dissertation advisor and advisory committee, be required to return to the Clemson campus subsequent to the performance of the mechanics of the research for the purpose of comprehensive review and analysis of the research.

4. *Continuous Enrollment.* The student must maintain continuous enrollment at Clemson University each semester while the research is in progress. It will be the student's responsibility to make suitable arrangements with the department to maintain this

continuous registration. Normally the student will not be required to register for summer sessions; however, he or she must be registered for the term that involves the review of the completed dissertation and/or the final examination.

5. *Supervision and Reports.* When doctoral research is conducted away from the Clemson campus and under the immediate direction of a dissertation supervisor who is employed by an organization other than Clemson University, in order to accommodate the student, as well as to exercise proper and necessary control over this important phase of doctoral study, the following requirements must be met:

- (a) An employee, having earned a Ph.D. and being engaged in the general subject area of the student's research, must be designated by an officer of the organization to supervise the student's research work.
- (b) The employee must be recommended to the provost by the appropriate college dean for appointment as an adjunct professor of Clemson University.
- (c) A résumé of the research supervisor must be submitted to the student's full advisory committee for its review and recommendation to the graduate dean.
- (d) The research supervisor must submit a final statement regarding the dissertation research, as well as interim reports if the committee deems such as necessary.
- (e) The off-campus research supervisor cannot serve as the student's major advisor.

## Comprehensive Examinations before Admission to Candidacy

Prior to taking the comprehensive examination before admission to candidacy, the doctoral student must have selected an advisory committee and filed an approved graduate degree curriculum (Form GS2) with the Graduate School.

Satisfactory completion of the comprehensive examination must occur no less than six months and no more than five years prior to the date of graduation. For examinations consisting of several parts (for example, a written plus an oral, or a written in cumulative format), the date of completion will coincide with the date of the last examination activity. However, the time span from the beginning to the end of the examination must not exceed twelve months, and failure of any portion that negates further examining will be reported as a failure of the examination. In the event that the completion date falls within a semester or session but all degree requirements have been met in a five-year period following the completion date, the student may receive the degree at the ensuing graduation ceremony.

A comprehensive examination is attempted only at the recommendation of the student's advisory committee after completion of most of the required course work. The function of the examination, which may be written or a combination of written and oral, is to obtain objective evidence of an adequate intellectual mastery of the areas of the major and minor specializations. This examination must be administered by the Clemson University program faculty offering the degree. The examining committee may be the student's advisory committee or a standing committee appointed in accordance with published program policies. A unanimous decision is not required; dissenting members of the examining committee should feel free to forward a minority report to the Graduate School.

The chairperson of the advisory committee will inform the Graduate School of the result, via Form GS5, within three weeks following the examination. The student's performance on this examination will determine whether he or she will be recommended for admission to candidacy for the degree.

Should the student fail to pass the comprehensive examination, he or she may be given a second opportunity if so recommended by the advisory committee. A second failure shall result in the



student being declared ineligible to receive the Doctor of Philosophy degree at Clemson University.

Some doctoral programs require preliminary or qualifying examinations prior to the comprehensive examination. Information about these examinations may be obtained from the individual departments.

### Final Doctoral Oral Examination

The candidate for the Doctor of Philosophy degree must pass a final oral examination (dissertation defense) at least three weeks prior to the time of the commencement at which he or she plans to obtain the degree. The examination will be conducted by the student's advisory committee, and all faculty members are invited to participate. The Graduate School will be notified of the time and place of the examination at least 10 days prior to the time scheduled. Members of the faculty, as well as members of the Graduate Curriculum Committee and the dean of the Graduate School, are invited to attend the examination.

This final examination demands a broad and penetrating interpretation by the student of the research project and conclusions. It may include examination of the student in the major and minor fields of specialization.

A student who fails a final oral examination may be allowed a second opportunity only with the recommendation of the advisory committee. Failure of the second examination will result in dismissal from the Graduate School.

### Doctor of Education Degree

Degree requirements pertaining to residence, time limit, and comprehensive and final examinations are the same as those for the Doctor of Philosophy degree. In addition, the candidate for the Doctor of Education degree must arrange with his or her advisory committee to engage in an internship appropriate to his or her field of professional service.

## GRADUATE PROGRAMS AND COURSE OFFERINGS

### Special Courses

These courses serve special needs for graduate students. They do not count toward a graduate degree, and no letter grades are given.

<b>G S 799</b>	<b>COMPREHENSIVE STUDIES</b> 1-15 cr. (1-15 and 0) Independent studies in preparation for comprehensive examinations; credit hours to be determined by the department head or program chair. A letter grade is not given, but satisfactory completion is indicated by a grade of "Credit."
<b>G S 800</b>	<b>RESEARCH PROPOSAL DEVELOPMENT SEMINAR</b> 1 cr. (1 and 0) Principles and techniques for the preparation of research proposals. Graded on a credit/no credit basis. Will not count toward a graduate degree. <b>Prerequisite:</b> Second year or graduate standing in current major.

### Explanation of Course Listings

Programs are listed alphabetically within the college that offers them. In certain departments which offer more than one course sequence, the secondary courses (not leading to a major or a minor) are listed immediately after those normally associated with the degree program or departmental name.

The list of courses offered under each program includes for each course the catalog number, title of course, credit in semester hours, class and laboratory hours per week and, for courses numbered 700

or above, the description of the course. Where courses are offered on a schedule, there is a designation F, S, SS or N following the class and laboratory hours, indicating whether the course is offered in the fall, spring, summer session or as needed. No designation indicates that the course is taught at least every year, but not necessarily during the same term. These designations are projections of the teaching schedules, and many factors can cause a change. It is the responsibility of the student to check with his or her department for verification of the scheduled offerings.

Graduate credit can be earned only for courses numbered 600 or above. Courses listed in this catalog in the 600-699 series are taught concurrently in the same classroom setting as the corresponding 300- and 400-series undergraduate courses. These are described in the general catalog, *Clemson University Undergraduate Announcements 1996-97*, which may be obtained from the director of undergraduate admissions.

Courses numbered in the 300 and 400 sequence are primarily for advanced undergraduates but are offered also for graduate credit when they carry the corresponding 600-level number. Students who receive graduate credit in such courses must do extra work of an appropriate nature as determined by the department and are graded according to graduate standards. Courses numbered 700 or above are restricted to graduate students and certain qualified Clemson University seniors.

Some course listings under certain programs may contain 700-, 800- and 900-level courses with a number, title, credits and hours, but no description. These courses are administered by departments other than the one under which they are listed. In these cases, a note will indicate where the descriptions are located.

A secondary listing of a course in parentheses implies that this course is cross-listed with another program. The course description appears with the parent course only.

The 700-level courses are designed primarily for the degrees that emphasize professional practice rather than research.

### Course Prefixes

This list of course offerings is arranged alphabetically and includes the course prefix used in the *Clemson University Graduate School Announcements*.

Accounting .....	ACCT
Agricultural and Applied Economics .....	APEC
Agricultural Education .....	AGED
Agricultural Engineering .....	AGE
Agricultural Mechanization .....	AGM
Agriculture .....	AGRIC
Agronomy .....	AGRON
Animal, Dairy and Veterinary Sciences .....	ADVSC
Animal Physiology .....	ANPH
Applied Psychology .....	PSYCH
Applied Sociology .....	SOC
Aquaculture, Fisheries and Wildlife Biology .....	WFB
Architecture .....	ARCH
Art and Architectural History .....	AAH
Astronomy .....	ASTR
Biochemistry .....	BIOCH
Bioengineering .....	BIOE
Biological Sciences .....	BIOSC
Biology .....	BIOL
Botany .....	BOT
Business Administration .....	MBA
Ceramic Engineering .....	CRE
Chemical Engineering .....	CHE
Chemistry .....	CH
City and Regional Planning .....	CRP
Civil Engineering .....	CE
Coaching Education .....	CED
Community and Rural Development .....	CRD
Computer Engineering .....	ECE



Computer Science .....	CP SC
Construction Science and Management .....	C S M
Economics .....	ECON
Education .....	ED
Educational Counseling .....	EDC
Educational Foundations .....	EDF
Educational Leadership .....	EDL
Electrical Engineering .....	E C E
Engineering Graphics .....	E G
Engineering Mechanics .....	E M
English .....	ENGL
Entomology .....	ENT
Environmental Science and Policy .....	EN SP
Environmental Systems Engineering .....	E S E
Environmental Toxicology .....	ENTOX
Experimental Statistics .....	EX ST
Finance .....	FIN
Fisheries Biology .....	W F B
Food Science .....	FD SC
Food Technology .....	FD TH
Forest Resources .....	FOR
French .....	FR
Genetics .....	GEN
Geography .....	GEOG
Geology .....	GEOL
German .....	GER
Government and International Studies .....	GINT
Graduate Studies .....	G S
Graphic Communications .....	G C
Health .....	HLTH
Health Administration .....	MHA
History .....	HIST
Horticulture .....	HORT
Human Resource Development .....	HRD
Hydrogeology .....	GEOL
Industrial Education .....	IN ED
Industrial Engineering .....	I E
Industrial Management .....	MGT
Industrial/Organizational Psychology .....	PSYCH
Integrated Pest Management .....	I P M
Law .....	LAW
Management .....	MGT
Management Science .....	MA SC
Marketing .....	MKT
Materials Science and Engineering .....	MAT E
Mathematical Sciences .....	MTHSC
Mechanical Engineering .....	M E
Microbiology .....	MICRO
Nursing .....	NURS
Nutrition .....	NUTR
Parks, Recreation and Tourism Management .....	PRTM
Performing Arts .....	THEA
Philosophy .....	PHIL
Physics .....	PHYS
Plant Pathology .....	PL PA
Plant Physiology .....	PL PH
Political Science .....	PO SC
Poultry Science .....	P S
Psychology .....	PSYCH
Public Administration .....	PO SC
Religion .....	REL
Rural Sociology .....	R S
Sociology .....	SOC
Spanish .....	SPAN
Special Education .....	EDSP
Speech .....	SPCH
Technology and Human Resource Development .....	THRD
Textile and Polymer Science .....	TEXT
Textile Chemistry .....	T C

Visual Arts .....	ART
Vocational/Technical Education .....	VT ED
Wildlife Biology .....	W F B
Zoology .....	ZOOL



School of Animal, Biomedical and Biological Sciences • 42

- Animal and Food Industries • 42
- Animal, Dairy and Veterinary Sciences • 42
- Animal Physiology • 43
- Biochemistry • 45
- Biological Sciences • 46
- Biology • 47
- Botany • 47
- Genetics • 48
- Microbiology • 49
- Nutrition • 50
- Poultry Science • 51
- Zoology • 52

School of Plant, Statistical and Ecological Sciences • 53

- Agronomy • 53
- Entomology • 54
- Experimental Statistics • 55
- Horticulture • 56
- Plant Pathology • 57
- Plant Physiology • 58

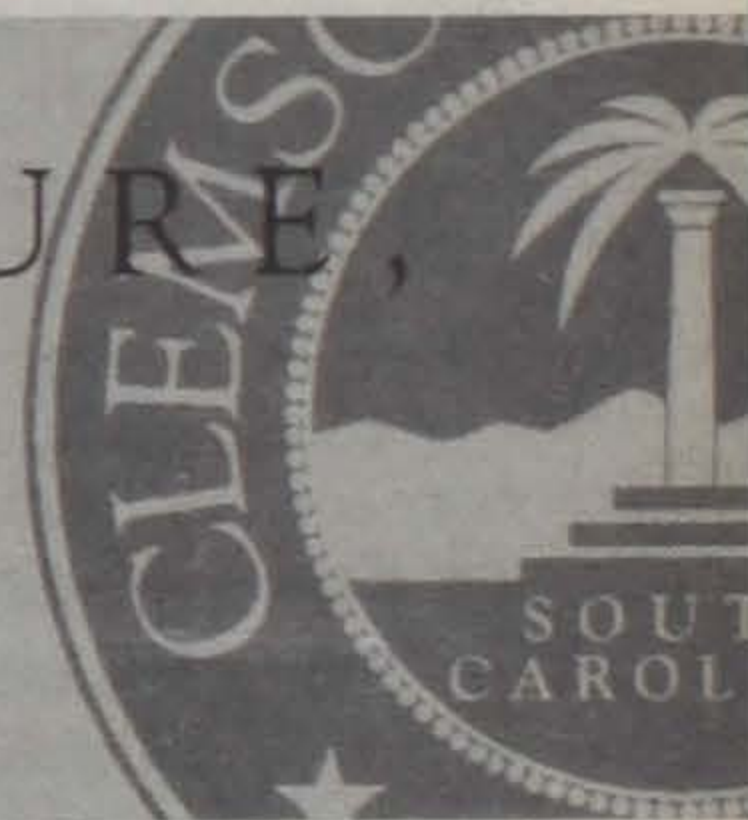
School of Natural and Recreational Resources • 59

- Aquaculture, Fisheries and Wildlife Biology • 59
- Forest Resources • 60

School of Applied Science and Agribusiness • 62

- Agricultural and Applied Economics • 62
- Agricultural Education • 65
- Agricultural Engineering • 66
- Agricultural Mechanization • 66
- Agriculture • 66
- Applied Economics • 67
- Environmental Toxicology • 67
- Food Science • 69
- Food Technology • 70

COLLEGE OF AGRICULTURE,  
FORESTRY AND LIFE  
SCIENCES





## COLLEGE OF AGRICULTURE, FORESTRY AND LIFE SCIENCES

William B. Wehrenberg, Dean

The College of Agriculture, Forestry and Life Sciences offers advanced degrees in these areas of study; concentrations within a major area are listed under the degree-granting program.

Agricultural and Applied Economics  
 Agricultural Education  
 Agricultural Engineering\*  
 Agricultural Mechanization  
 Agriculture  
 Agronomy  
 Animal and Food Industries  
 Animal, Dairy and Veterinary Sciences  
 Food Science  
 Poultry Science  
 Animal Physiology  
 Applied Economics\*\*  
 Aquaculture, Fisheries and Wildlife Biology  
 Biochemistry  
 Botany  
 Entomology  
 Environmental Toxicology \*\*\*  
 Food Technology  
 Forest Resources  
 Genetics  
 Horticulture  
 Microbiology  
 Nutrition  
 Plant Pathology  
 Plant Physiology  
 Zoology

Courses are offered in experimental statistics to provide a minor for students in other areas, and in biological sciences, biology, community and rural development, integrated pest management and rural sociology to provide electives for students in other areas.

The College of Agriculture, Forestry and Life Sciences offers graduate programs in 22 traditional disciplines in agriculture, forestry and a wide variety of biological sciences, from the fundamental to the applied. The college awards the M.S. and Ph.D. degrees as well as the Master of Agricultural Education, Master of Agriculture and Master of Forest Resources professional degrees. These postbaccalaureate degree programs are designed primarily to provide continuing education for individuals whose interests lie outside a research-oriented profession.

Through cooperative programs with state, federal and private agencies, students can extend their research off campus to the Greenwood Genetics Center, agricultural experiment stations spanning South Carolina, state and national forests of the Savannah River Basin, and the Caribbean island of Dominica. Proximity to the Blue Ridge Mountains provides access to one of the most biologically diverse regions in the world.

\* This program is administered jointly by the College of Agriculture, Forestry and Life Sciences and the College of Engineering and Science. The M.S. and Ph.D. degrees are awarded by the College of Engineering and Science.

\*\* This program is a cooperative effort between the Department of Agricultural and Applied Economics and the Department of Economics (College of Professional Studies). The Department of Agricultural and Applied Economics is responsible administratively for the Ph.D. program, and the degree is awarded by the College of Agriculture, Forestry and Life Sciences.

\*\*\* This program is administered jointly by the College of Agriculture, Forestry and Life Sciences and the College of Engineering and Science. The M.S. and Ph.D. degrees are awarded by the College of Agriculture, Forestry and Life Sciences.

## School of Animal, Biomedical and Biological Sciences

George C. Skelley, Lead Chair

### Animal and Food Industries

George C. Skelley, Chair, Department of Animal, Dairy and Veterinary Sciences

<b>Major</b>	<b>Degree</b>
Animal and Food Industries	M.S.

Students may concentrate in animal science, dairy science, food science or poultry science. See departmental listings in animal, dairy and veterinary sciences; food science; and poultry science for course descriptions. Candidates for the M.S. degree are required to complete a thesis.

### Animal, Dairy and Veterinary Sciences

George C. Skelley, Chair, Department of Animal, Dairy and Veterinary Sciences

<b>Majors</b>	<b>Degrees</b>
Animal and Food Industries	M.S.
Animal Physiology	M.S., Ph.D.
Nutrition	M.S., Ph.D.

A specific degree is not offered by this department, but the above degrees are granted through interdepartmental, interdisciplinary programs. Studies in animal production, nutrition, reproduction, meat and milk products, health and microbiology are offered. Excellent animal and laboratory facilities are available for graduate student research. Candidates must complete a research project and submit a thesis or dissertation. The department also participates in the animal industries option of the Master of Agriculture degree.

<b>ADVSC 600</b>	<b>DAIRY PROCESSING I</b> 4 cr. (3 and 3) S
<b>ADVSC 601</b>	<b>BEEF PRODUCTION</b> 4 cr. (3 and 2) F
<b>ADVSC 602</b>	<b>DAIRY PROCESSING II</b> 4 cr. (3 and 3) F
<b>ADVSC 603</b>	<b>LABORATORY TECHNIQUES</b> 3 cr. (2 and 3) F
<b>ADVSC 604</b>	<b>DAIRY CATTLE FEEDING AND MANAGEMENT</b> 4 cr. (3 and 2) S
<b>ADVSC 607</b>	<b>EQUINE THERIOGENOLOGY</b> 2 cr. (2 and 0) F
<b>ADVSC 608</b>	<b>PORK PRODUCTION</b> 4 cr. (3 and 2) S
<b>ADVSC 609</b>	<b>SELECTED TOPICS</b> 1-3 cr. (1-3 and 0)
<b>ADVSC 612</b>	<b>HORSE PRODUCTION</b> 4 cr. (3 and 2) S
<b>ADVSC 618</b>	<b>MUSCLE BIOLOGY AND LEAN MEATS</b> 3 cr. (2 and 2)
<b>ADVSC 652</b>	<b>ANIMAL BREEDING</b> 3 cr. (3 and 0) S
<b>ADVSC 653</b>	<b>ANIMAL REPRODUCTION</b> 3 cr. (2 and 2) F



- ADVSC 655 ANIMAL REPRODUCTIVE MANAGEMENT**  
1 cr. (0 and 3) S
- ADVSC 661 PHYSIOLOGY OF LACTATION**  
2 cr. (2 and 0) S
- ADVSC 801 SELECTED TOPICS**  
1-3 cr. (1-3 and 0)  
Current topics of special interest in animal, dairy or veterinary sciences not covered in other courses. May be repeated for credit. **Prerequisite:** Permission of coordinating instructor.
- ADVSC 802 MEAT TECHNOLOGY**  
3 cr. (3 and 0)  
Biochemistry, histology and microbiology of fresh, frozen, cured, smoked and processed meats; quality of meats and meat products, processing methods, nutritive value and research techniques. **Prerequisites:** ADVSC 253 and 255.
- ADVSC 803 PHYSIOLOGY OF REPRODUCTION AND MILK SECRETION**  
3 cr. (3 and 0)  
Development of advanced concepts of steroidogenesis, gametogenesis, fertilization, placentation, embryogenesis, embryonic-endometrial relationships, parturition and lactation, and the influence of hormones on these processes. Students evaluate the most recent scientific literature in these areas for information, experimental methods and validity of authors' conclusions, and select a problem, review related literature and write a research proposal for solving the problem. **Prerequisites:** ADVSC 453 and 461 or permission of instructor.
- ADVSC 804 METHODS IN ANIMAL BREEDING**  
3 cr. (3 and 0)  
Gene and zygotic frequency; system of mating; heritabilities; genetic consequences of selection; and criteria for evaluating improvement in all domestic livestock. **Prerequisite:** ADVSC 452/652.
- ADVSC 808 INDUSTRIAL DAIRY AND MEAT SCIENCE**  
3 cr. (1 and 6)  
Managerial training for operating food plants with particular emphasis on regulations, policy and decision making for dairy plants and meat plants. **Prerequisites:** ADVSC 253, 255 and 400 or permission of instructor.
- ADVSC 820 ANIMAL, DAIRY AND VETERINARY SCIENCES GRADUATE SEMINAR**  
1 cr. (1 and 0)  
Ongoing research, evaluation of research needs, research techniques, critical reviews and discussions of published research in all areas of the animal, dairy and veterinary sciences. **Prerequisite:** Graduate standing.
- ADVSC 822 SPECIAL PROBLEMS**  
1-3 cr. (0 and 3-9)  
Laboratory, library or field study of problems related to animal, dairy and veterinary sciences emphasizing development and testing of

hypotheses and reporting of results. May be repeated for a maximum of four credits. **Prerequisite:** Permission of instructor supervising study.

- ADVSC 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.

### Animal Physiology

John R. Diehl, Program Coordinator, Department of Animal, Dairy and Veterinary Sciences

**Major**  
Animal Physiology

**Degrees**  
M.S., Ph.D.

Animal physiology is an interdepartmental graduate program developed and offered by faculty in the departments of Animal, Dairy and Veterinary Sciences; Aquaculture, Fisheries and Wildlife; and The Institute of Wildlife and Environmental Toxicology. Applicants should have a strong background in the biological and physical sciences. Students with deficiencies in these sciences may be admitted provided they correct these deficiencies during the first year of their program of study.

Students enrolled in the M.S. program are required to complete AN PH 660, BIOCH 623, EX ST 801 and BIOSC 659 and 660, except as waived by the student's graduate advisory committee if equivalent courses have been taken already. Additional course work may be taken in areas of the student's interest as approved by the graduate advisory committee. The student's program and research emphasize a study of physiological processes, particularly those relating to reproduction, endocrinology, digestion and environmental factors. A thesis is required.

The Ph.D. degree does not have formal course work requirements, but it is recognized that students will have individual deficiencies. Therefore, it is the responsibility of the student and his or her major advisor, in consultation with the graduate advisory committee, to prescribe course work to correct these deficiencies. All students majoring in animal physiology are required to complete AN PH 851.

- AN PH 660 SYSTEMS PHYSIOLOGY**  
1 cr. (1 and 0) F

- AN PH 801 (BIOSC 801) ELECTRON MICROSCOPY OF BIOLOGICAL SPECIMENS**  
3 cr. (1 and 6) F, S  
Concepts and practice in preparing biological specimens for electron microscopy: fixing, embedding, thin-sectioning, staining, operating microscopes and photographing, developing, printing and interpreting micrographs. Each student must achieve proficiency with a selected specimen, including writing a brief research proposal, preparing specimen, studying specimen with electron microscope and interpreting micrographs. **Prerequisite:** Permission of instructor.

- AN PH 802 SELECTED TOPICS**  
1-3 cr. (1-3 and 0-3) F, S  
Current topics of special interest in animal physiology not covered in other courses. May be repeated for a maximum of six credits. **Prerequisite:** Permission of instructor.



- AN PH 806 CARE AND USE OF RESEARCH ANIMALS**  
3 cr. (1 and 6) F  
Demonstration and practice of humane use and care of animals in research; study of pain, analgesia and anesthesia; regulatory aspects of the use of animals in teaching and research; surgical techniques and sample collection. **Prerequisites:** BIOSC 459/659 and AN PH 460/660 or permission of instructor.
- AN PH 807 SPECIAL PROBLEMS IN ANIMAL PHYSIOLOGY**  
1-3 cr. (1-3 and 0)  
Research not related to a thesis. May include a comprehensive review of related literature.
- AN PH 808 CURRENT CONCEPTS IN ENDOCRINOLOGY**  
3 cr. (3 and 0) S  
Advanced concepts relevant to interrelationships between the nervous and endocrine systems as they influence growth and development, body metabolism and regulatory mechanisms, reproduction and lactation. **Prerequisites:** AN PH 660 and BIOSC 680, or BIOCH 817, or permission of coordinator.
- AN PH 812 DIGESTIVE-METABOLIC, EXCRETORY AND RESPIRATORY PHYSIOLOGY**  
5 cr. (4 and 3) F (even numbered years)  
Development of advanced concepts of mechanisms and functions of gastrointestinal tract (mastication, salivation, digestion, absorption, metabolism, excretion), kidney (anatomy, filtration, secretion, reabsorption) and respiratory systems (transport, exchange and utilization of gases); the action of the nervous system, hormones and pharmacologic agents on these organ systems. **Prerequisites:** BIOSC 659 and AN PH 660 or permission of course coordinator.
- AN PH 814 MEMBRANE, CARDIOVASCULAR AND NEUROMUSCULAR PHYSIOLOGY**  
5 cr. (4 and 3) S (even numbered years)  
Development of advanced concepts in membrane physiology (permeability, action potentials, specialized functions), cardiovascular physiology (functions of the heart, blood-vascular system in maintaining acid-base balance, clotting mechanisms, homeostasis, circulation), neuromuscular physiology (anatomy and function of the nervous system, special senses, reflexes, control of muscular activity); and the action of several pharmacologic agents on muscle and nerve functions. **Prerequisites:** BIOSC 659 and AN PH 660 or permission of course coordinator.
- AN PH 851 ANIMAL PHYSIOLOGY SEMINAR**  
1 cr. (1 and 0) F, S  
Current research and development in animal physiology through related literature and student and faculty participation. May be repeated for a maximum of two credit hours.

- AN PH 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.

- AN PH 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

*The following courses offered by various departments represent possible electives for the student in animal physiology. Descriptions for all 800-level courses are under the respective departmental headings.*

- ADVSC 653 ANIMAL REPRODUCTION**  
3 cr. (2 and 2) F
- ADVSC 655 ANIMAL REPRODUCTIVE MANAGEMENT**  
1 cr. (0 and 3) S
- ADVSC 661 PHYSIOLOGY OF LACTATION**  
2 cr. (2 and 0) S
- ADVSC 803 PHYSIOLOGY OF REPRODUCTION AND MILK SECRETION**  
3 cr. (3 and 0)
- BIOCH 606 PHYSIOLOGICAL CHEMISTRY**  
3 cr. (3 and 0)
- BIOCH 623 PRINCIPLES OF BIOCHEMISTRY**  
3 cr. (3 and 0)
- BIOCH 633 GENERAL BIOCHEMISTRY LABORATORY I**  
2 cr. (0 and 4)
- BIOCH 634 GENERAL BIOCHEMISTRY LABORATORY II**  
2 cr. (0 and 4)
- BIOCH 815 LIPIDS AND BIOMEMBRANES**  
3 cr. (3 and 0)
- BIOCH 817 CHEMISTRY AND METABOLISM OF HORMONES**  
3 cr. (3 and 0)
- BIOSC 632 ANIMAL HISTOLOGY**  
3 cr. (3 and 0)
- BIOSC 633 ANIMAL HISTOLOGY LABORATORY**  
2 cr. (1 and 2)
- BIOSC 659 SYSTEMS PHYSIOLOGY**  
3 cr. (3 and 0)
- BIOSC 660 SYSTEMS PHYSIOLOGY LABORATORY**  
2 cr. (1 and 2)
- BIOSC 661 CELL BIOLOGY**  
3 cr. (3 and 0)
- BIOSC 670 ANIMAL BEHAVIOR**  
3 cr. (3 and 0)
- BIOSC 671 ANIMAL BEHAVIOR LABORATORY**  
1 cr. (0 and 3)
- BIOSC 675 COMPARATIVE PHYSIOLOGY**  
3 cr. (3 and 0)
- BIOSC 676 COMPARATIVE PHYSIOLOGY LABORATORY**  
2 cr. (1 and 2)



<b>BIOSC 680</b>	<b>VERTEBRATE ENDOCRINOLOGY</b> 3 cr. (3 and 0)
<b>ENT 640</b>	<b>INSECT BEHAVIOR</b> 3 cr. (2 and 3)
<b>ENT 670</b>	<b>INSECT PHYSIOLOGY</b> 3 cr. (2 and 3)
<b>EX ST 801</b>	<b>STATISTICAL METHODS</b> 4 cr. (3 and 3) F, S
<b>EX ST 803</b>	<b>REGRESSION AND LEAST SQUARES ANALYSIS</b> 3 cr. (3 and 0) F
<b>EX ST 805</b>	<b>DESIGN AND ANALYSIS OF EXPERIMENTS</b> 3 cr. (3 and 0) F, S
<b>MICRO 614</b>	<b>BASIC IMMUNOLOGY</b> 3 cr. (2 and 3) F
<b>MICRO 811</b>	<b>BACTERIAL CYTOLOGY AND PHYSIOLOGY</b> 4 cr. (4 and 0) S (odd numbered years)
<b>P S 600</b>	<b>AVIAN PHYSIOLOGY</b> 3 cr. (3 and 0) S (even numbered years)
<b>P S 825</b>	<b>IMMUNOBIOLOGY</b> 3 cr. (3 and 0) S

### Biochemistry

W.R. Marcotte, Program Coordinator, Department of Biological Sciences

**Major**  
Biochemistry

**Degrees**  
M.S., Ph.D.

Enrollment in the biochemistry program is open to students with baccalaureate degrees in agricultural, biological or physical sciences, or engineering. Entering students must have satisfactory academic records in mathematical, physical and biological sciences. Students with deficiencies may be admitted but will be required to correct these deficiencies during the first year.

Attendance and participation in departmental seminars are mandatory for all graduate students.

Biochemistry 631, 632, 633 and 634 (10 total credit hours) constitute the core of the biochemistry program. All students are expected to complete these courses if they have not had their equivalents at another accredited institution.

In addition to core courses, the M.S. degree requires a minimum of 14 credit hours of course work. At least eight of these 800-level credits (including two credits of BIOCH 851) must be in biochemistry courses. Two of the following four courses are required: BIOCH 815, 822, 831 and 841. A minimum of six semester hours of M.S. research, culminating in a thesis, is required.

The Ph.D. degree requires, in addition to the core courses, BIOCH 634 and three of the four courses: BIOCH 815, 822, 831 and 841. Successful completion of written and oral comprehensive examinations (before six semesters in residence) will admit the student to candidacy for the Ph.D. degree.

<b>BIOCH 606</b>	<b>PHYSIOLOGICAL CHEMISTRY</b> 3 cr. (3 and 0)
<b>BIOCH 623</b>	<b>PRINCIPLES OF BIOCHEMISTRY</b> 3 cr. (3 and 0)
<b>BIOCH 631</b>	<b>A PHYSICAL APPROACH TO BIOCHEMISTRY</b> 3 cr. (3 and 0)

<b>BIOCH 632</b>	<b>BIOCHEMISTRY OF METABOLISM</b> 3 cr. (3 and 0)
<b>BIOCH 633</b>	<b>GENERAL BIOCHEMISTRY LABORATORY I</b> 2 cr. (0 and 4)
<b>BIOCH 634</b>	<b>GENERAL BIOCHEMISTRY LABORATORY II</b> 2 cr. (0 and 4)
<b>BIOCH 815</b>	<b>LIPIDS AND BIOMEMBRANES</b> 3 cr. (3 and 0) Isolation, chemical and physical properties and metabolism of lipids; purification, structure, function and biosynthesis of biomembranes. <b>Prerequisite:</b> BIOCH 432/632 or permission of instructor.
<b>BIOCH 817</b>	<b>CHEMISTRY AND METABOLISM OF HORMONES</b> 3 cr. (3 and 0) Isolation, assay and chemistry of the various hormones; hormonal control of metabolism and body functions; endocrinopathies of hormone imbalance. <b>Prerequisite:</b> BIOCH 432/632 or permission of instructor.
<b>BIOCH 821</b>	<b>PROTEINS</b> 3 cr. (3 and 0) Isolation, composition, structure and properties of proteins; methods of isolation, analysis and characterization; properties of "unusual" protein systems. <b>Prerequisite:</b> BIOCH 431/631 or 423/623 or permission of instructor.
<b>BIOCH 822</b>	<b>ENZYMES</b> 3 cr. (3 and 0) Kinetics, mechanisms of action, inhibitions and general properties of enzymes. <b>Prerequisite:</b> BIOCH 431/631 or 423/623.
<b>BIOCH 831</b>	<b>PHYSICAL BIOCHEMISTRY</b> 3 cr. (3 and 0) Description and theory of physical methods and instrumentation used in analysis of biological macromolecules. <b>Prerequisites:</b> BIOCH 431/631 or 423/623, and one semester of physical chemistry or permission of instructor.
<b>BIOCH 841</b>	<b>BIOCHEMICAL GENETICS</b> 3 cr. (3 and 0) Regulation of replication and transcription; students present papers from recent literature and write a research proposal. <b>Prerequisite:</b> One year of biochemistry or permission of instructor.
<b>BIOCH 851</b>	<b>BIOCHEMISTRY SEMINAR</b> 1 cr. (1 and 0) Students review current topics in biochemistry.
<b>BIOCH 891</b>	<b>MASTER'S THESIS RESEARCH</b> Credit to be arranged.
<b>BIOCH 991</b>	<b>DOCTORAL DISSERTATION RESEARCH</b> Credit to be arranged.



**Biological Sciences**

James K. Zimmerman, Chair, Department of Biological Sciences

Advanced degrees are not awarded in biological sciences as a major. These courses are taught by faculty in the Department of Biological Sciences to supplement courses and graduate degrees awarded in biochemistry, botany, genetics and zoology.

<b>BIOSC 601</b>	<b>PLANT PHYSIOLOGY</b> 3 cr. (3 and 0)	<b>BIOSC 640</b>	<b>DEVELOPMENTAL ANIMAL BIOLOGY</b> 3 cr. (3 and 0)
<b>BIOSC 602</b>	<b>PLANT PHYSIOLOGY LABORATORY</b> 1 cr. (0 and 3)	<b>BIOSC 641</b>	<b>ECOLOGY</b> 3 cr. (3 and 0)
<b>BIOSC 603</b>	<b>PROTOZOOLOGY</b> 3 cr. (3 and 0)	<b>BIOSC 642</b>	<b>BIOGEOGRAPHY</b> 3 cr. (3 and 0)
<b>BIOSC 604</b>	<b>PROTOZOOLOGY LABORATORY</b> 2 cr. (1 and 2)	<b>BIOSC 643</b>	<b>AQUATIC ECOLOGY</b> 3 cr. (3 and 0)
<b>BIOSC 605</b>	<b>MOLECULAR GENETICS OF EUKARYOTES</b> 3 cr. (3 and 0)	<b>BIOSC 645</b>	<b>ECOLOGY LABORATORY</b> 2 cr. (1 and 2)
<b>BIOSC 606</b>	<b>INTRODUCTORY PLANT TAXONOMY</b> 3 cr. (3 and 0)	<b>BIOSC 646</b>	<b>PLANT ECOLOGY</b> 3 cr. (3 and 0)
<b>BIOSC 607</b>	<b>PLANT TAXONOMY LABORATORY</b> 1 cr. (0 and 3)	<b>BIOSC 647</b>	<b>PLANT ECOLOGY LABORATORY</b> 2 cr. (1 and 2)
<b>BIOSC 608</b>	<b>COMPARATIVE VERTEBRATE MORPHOLOGY</b> 3 cr. (3 and 0)	<b>BIOSC 650</b>	<b>DEVELOPMENTAL BIOLOGY LABORATORY</b> 2 cr. (1 and 2)
<b>BIOSC 609</b>	<b>COMPARATIVE VERTEBRATE MORPHOLOGY LABORATORY</b> 1 cr. (0 and 3)	<b>BIOSC 652</b>	<b>PLANT ANATOMY AND MORPHOLOGY</b> 3 cr. (3 and 0)
<b>BIOSC 610</b>	<b>LIMNOLOGY</b> 3 cr. (3 and 0)	<b>BIOSC 653</b>	<b>PLANT ANATOMY AND MORPHOLOGY LABORATORY</b> 2 cr. (1 and 2)
<b>BIOSC 611</b>	<b>LIMNOLOGICAL ANALYSES</b> 2 cr. (1 and 2)	<b>BIOSC 656</b>	<b>MEDICAL AND VETERINARY PARASITOLOGY</b> 3 cr. (3 and 0)
<b>BIOSC 616</b> (GEN 616)	<b>RECOMBINANT DNA</b> 3 cr. (3 and 0)	<b>BIOSC 657</b>	<b>MEDICAL AND VETERINARY PARASITOLOGY LABORATORY</b> 2 cr. (1 and 2)
<b>BIOSC 618</b> (MICRO 618) (GEN 618)	<b>BIOTECHNOLOGY I: NUCLEIC ACIDS TECHNIQUES</b> 4 cr. (2 and 4) N	<b>BIOSC 658</b> (AG E 658)	<b>CELL PHYSIOLOGY</b> 3 cr. (3 and 0)
<b>BIOSC 620</b>	<b>NEUROBIOLOGY</b> 3 cr. (3 and 0)	<b>BIOSC 659</b>	<b>SYSTEMS PHYSIOLOGY</b> 3 cr. (3 and 0)
<b>BIOSC 625</b>	<b>INTRODUCTORY MYCOLOGY</b> 3 cr. (3 and 0)	<b>BIOSC 660</b>	<b>SYSTEMS PHYSIOLOGY LABORATORY</b> 2 cr. (1 and 2)
<b>BIOSC 626</b>	<b>MYCOLOGY PRACTICUM</b> 2 cr. (1 and 2)	<b>BIOSC 661</b>	<b>CELL BIOLOGY</b> 3 cr. (3 and 0)
<b>BIOSC 630</b> (AG E 630)	<b>ENGINEERING MODELING OF BIOLOGICAL SYSTEMS</b> 3 cr. (3 and 0)	<b>BIOSC 662</b>	<b>CELL BIOLOGY LABORATORY</b> 2 cr. (1 and 2)
<b>BIOSC 632</b>	<b>ANIMAL HISTOLOGY</b> 3 cr. (3 and 0)	<b>BIOSC 664</b>	<b>MAMMALOGY</b> 3 cr. (2 and 3)
<b>BIOSC 633</b>	<b>ANIMAL HISTOLOGY LABORATORY</b> 2 cr. (1 and 2)	<b>BIOSC 665</b>	<b>PLANT MOLECULAR BIOLOGY</b> 3 cr. (3 and 0)
<b>BIOSC 635</b>	<b>PRINCIPLES OF EVOLUTION</b> 4 cr. (4 and 0)	<b>BIOSC 670</b>	<b>ANIMAL BEHAVIOR</b> 3 cr. (3 and 0)
		<b>BIOSC 671</b>	<b>ANIMAL BEHAVIOR LABORATORY</b> 1 cr. (0 and 3)
		<b>BIOSC 675</b>	<b>COMPARATIVE PHYSIOLOGY</b> 3 cr. (3 and 0)
		<b>BIOSC 676</b>	<b>COMPARATIVE PHYSIOLOGY LABORATORY</b> 2 cr. (1 and 2)



- BIOSC 680 VERTEBRATE ENDOCRINOLOGY**  
3 cr. (3 and 0)
- BIOSC 801 ELECTRON MICROSCOPY OF BIOLOGICAL SPECIMENS**  
(AN PH 801) 3 cr. (1 and 6) F, S  
See AN PH 801 for description.
- BIOSC 815 DEVELOPMENTAL GENETICS**  
3 cr. (3 and 0)  
Current research in developmental genetics. Topics include model systems, homeotic genes of *Drosophila*, primary induction, adhesion molecules and cancer, axis formation, global pattern mutants in plants, homeobox genes in plants and photo regulation. **Prerequisites:** A semester of biochemistry and a semester of genetics.
- BIOSC 871 SELECTED TOPICS**  
1-4 cr. (1-4 and 0)  
Cellular and developmental biology, ecology, behavior, evolutionary biology, molecular biology, physiology, systematics and other topics of interest to graduate students in the biological sciences. May be repeated for credit, but only if different topics are covered. **Prerequisite:** Permission of instructor.
- BIOSC 872 SELECTED TOPICS LABORATORY**  
1-4 cr. (0 and 2-8)  
Specialized laboratory experiences in cellular and developmental biology, ecology, behavior, evolutionary biology, molecular biology, physiology, systematics and other topics of interest to graduate students in the biological sciences. May be repeated for credit, but only if different topics are covered. **Prerequisite:** Permission of instructor.

## Biology

William M. Surver, Chair, Faculty of Biology Program

The Biology Program does not offer advanced degrees; see the Department of Biological Sciences for graduate programs in biology. The courses listed below are taught by faculty in the life sciences for elementary and secondary education majors.

- BIOL 710 SELECTED TOPICS FOR TEACHERS**  
1-6 cr. (0-6 and 0-18)  
Study of one or more topics organized according to institute needs; lecture and laboratory emphasize the incorporation of new or updated subject matter into classroom instruction. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered.

## Botany

John E. Fairey, Program Coordinator, Department of Biological Sciences

Majors	Degrees
Botany	M.S.
Plant Physiology	Ph.D.

Candidates for graduate work in botany or plant physiology should have a strong undergraduate background in the biological and physical sciences. Undergraduate curricula which may provide this background are botany, biology or chemistry, or one of

the agricultural plant sciences such as agronomy, forest resources or horticulture.

All candidates for the Master of Science degree must complete 24 semester hours of course work and six hours of research, and must present and defend a thesis based on original research. Research topics generally are selected from one of the following areas: taxonomy/ biosystems, cytology, development, ecology, mycology, phycology or physiology.

In addition to the Master of Science degree in botany, the department participates in an interdepartmental program awarding the Doctor of Philosophy degree with a major in plant physiology. This program offers considerable opportunity for doctoral research in botany. It is described under Plant Physiology.

- BOT 613 PHYCOLOGY**  
4 cr. (3 and 3) S (even numbered years)
- BOT 807 SEMINAR**  
1 cr. (1 and 0) F, S  
Areas of botanical sciences not covered in other courses; student reviews literature, organizes and presents material. May be taken for credit only twice.
- BOT 821 INORGANIC PLANT METABOLISM**  
3 cr. (3 and 0) F (odd numbered years)  
Plant, soil, water and nutrient relations; permeability; uptake and translocation; transpiration; mineral nutrition. **Prerequisites:** BIOSC 401/601 and 402/602 or permission of instructor.
- BOT 822 ORGANIC PLANT METABOLISM**  
3 cr. (3 and 0) S (even numbered years)  
Respiration and photosynthesis; synthesis, translocation, storage, transformation and degradation of organic materials, fats, carbohydrates, proteins, pigments and nucleic acids. **Prerequisites:** BIOSC 601 and 602 and BIOCH 623, or permission of instructor.
- BOT 823 PLANT GROWTH AND DEVELOPMENT**  
3 cr. (3 and 0) F (even numbered years)  
Vegetative and reproductive growth and development from seed to maturity, flowering, fruiting and senescence; natural and synthetic growth regulators; morphogenesis. **Prerequisites:** BIOSC 401/601 and 402/602, organic chemistry or permission of instructor.
- BOT 824 MODE OF ACTION OF GROWTH SUBSTANCES**  
4 cr. (3 and 3) S (odd numbered years)  
Physiology and biochemistry of both natural and synthetic growth regulators, hormones, growth retardants, herbicides and other inhibitors; methodology and mechanism of action. **Prerequisites:** BIOSC 401/601 and 402/602 and general biochemistry, or BOT 822 or permission of instructor.
- BOT 831 ADVANCED PLANT TAXONOMY**  
4 cr. (3 and 3) S (odd numbered years)  
Principles of plant classification; relationships and characteristics of major groups of vascular plants; student collects and identifies spring flora of area. **Prerequisite:** BIOSC 406/606 or permission of instructor.



- BOT 846 PLANT ECOLOGY**  
4 cr. (3 and 3) F  
Detailed study of the effects of environmental factors upon plants and the influence of plants upon the environment; identification and analysis of interrelated biotic and physical factors that affect the structure, distribution and dynamics of individual plants, plant populations and ecosystems. **Prerequisite:** BIOSC 441/641 or permission of instructor.
- BOT 847 PLANT-ANIMAL INTERACTIONS**  
3 cr. (3 and 0)  
Examination of plant-animal interactions from an ecological and evolutionary perspective. Topics include herbivory, pollination and seed dispersal as well as effects of animals on plant populations and influence of plants on animal diversity and abundance. **Prerequisite:** BIOSC 441/641 or BIOSC 446/646 or permission of instructor.
- BOT 850 PLANT TISSUE AND CELL CULTURE**  
3 cr. (2 and 3) F (odd numbered years)  
Consideration of methods and principles of plant tissue and cell culture: cloning, embryogenesis, protoplast fusion, plant regeneration, potential of plant genetic engineering. **Prerequisite:** Introductory plant physiology or permission of instructor.
- BOT 851 (HORT 851) PLANT ANATOMY**  
3 cr. (2 and 3) F (odd numbered years)  
Study of the origin, development and comparative structures of tissues, systems and organs of higher plants. **Prerequisite:** BIOSC 452/652 or permission of instructor.
- BOT 861 PLANT CELL BIOLOGY**  
3 cr. (3 and 0) F (odd numbered years)  
Structure, development and activities of plant cells; ultrastructural organization uniquely associated with dynamics of cellular growth and development in plants. **Prerequisites:** BIOSC 401/601 and 402/602 or permission of instructor.
- BOT 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- BOT 921 (HORT 921) PLANT PHYSIOLOGY COLLOQUIUM**  
1 cr. (1 and 0)  
Topics from current plant physiology literature provide a forum for criticizing research, conceiving new research ideas, developing research outlines and proposals, and integrating knowledge from various subdisciplines of plant physiology. May be repeated for credit. **Prerequisites:** BIOSC 401/601 and 402/602 or permission of instructor.
- BOT 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

## Genetics

Albert G. Abbott, Program Coordinator, Department of Biological Sciences

### Major Genetics

### Degrees M.S., Ph.D.

The M.S. and Ph.D. degrees in genetics are offered through an interdepartmental program. Applied and basic research emphasis areas include animal, plant, molecular, microbial, biometrical and environmental bioremediation genetics.

Applicants to the program must have a bachelor's or master's degree in any area; chemistry through organic or biochemistry; a minimum of four credits of physics; mathematics through calculus; and biology including introductory genetics. Students with more than 18 hours of deficiencies will be admitted as postbaccalaureate enrollees until eligibility for graduate status is attained.

GEN 616 and 651 are required of all students. In addition, four of the following eight courses must be completed for the M.S. or Ph.D. degree: GEN/BIOSC/MICRO 618, MICRO 615, AGRON 605, ADVSC 652, BIOSC 665, GEN 812, BIOCH 815 and BIOCH 841. Other 800-level courses pertinent to the program of study and research are planned by the student and advisory committee to provide the student with a comprehensive knowledge of genetics.

The M.S. degree requires completion of 30 semester hours, including 24 hours of course work, six hours of research and a research thesis. Twelve of the required 24 hours of course work must be 800-level courses. The Ph.D. degree requires 18 hours of doctoral research credit, a research dissertation and a minimum of 24 hours of course work beyond the bachelor's degree. The course work is specified by the student's advisory committee with concurrence of the Genetics Program Committee.

- |  |   |
|--|---|
| <b>GEN 616 (BIOSC 616)</b>             | <b>RECOMBINANT DNA</b><br>3 cr. (3 and 0)   |
| <b>GEN 618 (MICRO 618) (BIOSC 618)</b> | <b>BIOTECHNOLOGY I: NUCLEIC ACIDS TECHNIQUES</b><br>4 cr. (2 and 4) N   |
| <b>GEN 651</b>                         | <b>ADVANCED GENETICS</b><br>3 cr. (3 and 0) F   |
| <b>GEN 701</b>                         | <b>MODERN DEVELOPMENTS IN GENETICS</b><br>3 cr. (3 and 0)<br>Contemporary developments in genetics for secondary school teachers; genetic approaches to the problems of health and behavior; methods and equipment used to illustrate principles of genetics in theory and in the laboratory. <b>Prerequisite:</b> A genetics course or equivalent in biology courses.  |
| <b>GEN 801</b>                         | <b>CYTOGENETICS</b><br>3 cr. (2 and 3) S (odd numbered years)<br>Classical and contemporary problems of chromosome structure, behavior and transmission; recombination; interspecific hybridization; euchromatin and heterochromatin; polyploidy; mutable genetic systems; structural and numerical aberrations of chromosomes and their effects upon breeding systems of plants and animals. <b>Prerequisite:</b> GEN 302 or equivalent. |
| <b>GEN 803</b>                         | <b>BIOMETRICAL GENETICS</b><br>3 cr. (3 and 0) S<br>Statistical methodology in the study of population genetics; probability as applied to genetic systems, gene and zygotic frequencies, derivation of genetic expectations, forces that change  |



gene frequency, inbreeding, estimation and testing of genetic parameters, partitioning of variance, responses to selection and other statistical aspects of continuous variation. **Prerequisites:** GEN 451/651 and EX ST 801 or equivalent.

- GEN 806 SPECIAL PROBLEMS IN GENETICS**  
1-3 cr. (0 and 3-9)  
Research not related to a thesis.
- GEN 812 PHYSIOLOGICAL GENETICS**  
3 cr. (3 and 0)  
Advanced topics in the molecular aspects of physiological genetics. Topics include genes and metabolism, genes and signal transduction, oncogenes and growth, chromosomal aberrations, immunogenetics and others. **Prerequisites:** A semester of biochemistry and introductory genetics.
- GEN 825 GENETICS SEMINAR**  
1 cr. (1 and 0)  
Special topics and original research in genetics reviewed by students, faculty and invited lecturers. May be repeated for credit. **Prerequisite:** One semester of genetics.
- GEN 890 SPECIAL TOPICS IN GENETICS**  
1-3 cr. (1-3 and 0)  
Group discussion of recent developments in genetic research. May be repeated for a maximum of six credit hours. **Prerequisites:** GEN 302 and permission of instructor.
- GEN 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- GEN 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

## Microbiology

Steven S. Hayasaka, Chair, Department of Microbiology

**Major**  
Microbiology

**Degrees**  
M.S., Ph.D.

Graduate work in microbiology requires sound undergraduate training in the biological and physical sciences. This training may be received in an undergraduate program in biology (botany, microbiology or zoology), chemistry or in one of the agricultural sciences. Undergraduate work in bacteriology or microbiology is desirable but not necessary.

All students complete a curriculum which assures a sound knowledge of the basic areas of microbiology including at least three of the following: bacterial physiology and metabolism, pathogenic microbiology, virology, immunology, microbial genetics, and applied and environmental microbiology. The program is selected by the student with the guidance and approval of an advisory committee.

Candidates for the M.S. degree must complete 30 hours of graduate credit including six hours of research, and present and defend a thesis based on original research.

Candidates for the Ph.D. degree must complete 18 hours of dissertation research, and present and defend a dissertation based on original research. Research disciplines include pathogenic, food, environmental and marine microbiology; immunology; microbial ecology; human bacterial and plant virology; molecular biology; microbial genetics; genetic engineering; microbial physiology and metabolism; and anaerobic microbiology.

- MICRO 600 PUBLIC HEALTH MICROBIOLOGY**  
3 cr. (3 and 0) S
- MICRO 601 ADVANCED BACTERIOLOGY**  
4 cr. (2 and 6) F
- MICRO 603 MARINE MICROBIOLOGY**  
3 cr. (2 and 3) N
- MICRO 605 GENERAL MICROBIOLOGY**  
4 cr. (3 and 3)
- MICRO 607 FOOD AND DAIRY MICROBIOLOGY**  
4 cr. (3 and 3) S
- MICRO 610 SOIL MICROBIOLOGY**  
3 cr. (2 and 3) S (even numbered years)
- MICRO 611 PATHOGENIC BACTERIOLOGY**  
4 cr. (3 and 3) S
- MICRO 612 BACTERIAL PHYSIOLOGY**  
4 cr. (3 and 3) S
- MICRO 613 INDUSTRIAL MICROBIOLOGY**  
3 cr. (2 and 3) F
- MICRO 614 BASIC IMMUNOLOGY**  
3 cr. (2 and 3) F
- MICRO 615 MICROBIAL GENETICS**  
4 cr. (3 and 3) S
- MICRO 616 INTRODUCTORY VIROLOGY**  
3 cr. (3 and 0) F
- MICRO 617 MOLECULAR MECHANISMS OF CARCINOGENESIS AND AGING**  
3 cr. (3 and 0) S
- MICRO 618 (BIOSC 618) (GEN 618) BIOTECHNOLOGY I: NUCLEIC ACIDS TECHNIQUES**  
4 cr. (2 and 4) N
- MICRO 802 BACTERIOLOGICAL TECHNIC**  
4 cr. (2 and 6) F  
Analytical and experimental procedures used in bacteriology including techniques for studying bacterial cytology, physiology and metabolism; designed to give students experience in more advanced methods of investigation.
- MICRO 803 SPECIAL PROBLEMS IN MICROBIOLOGY**  
Credit to be arranged. F, S, SS  
Research not related to a thesis.
- MICRO 804 SELECTED TOPICS IN MICROBIOLOGY**  
1-3 cr. (1-3 and 0) F, S, SS  
Evaluation of current research literature in various areas of microbiology; critical evaluation of specific publications in terms of their scientific merit; required of all microbiology graduate students. May be repeated for credit.



- MICRO 805** **TECHNIQUES OF CLINICAL MICROBIOLOGY AND IMMUNOBIOLOGY**  
3 cr. (2 and 3)  
Methods for isolating, identifying and culturing different mammalian cell types; techniques used to analyze cell function and viability and for protein and DNA analysis emphasizing application to the diagnosis of disease, determination of prognosis, optimization of treatment and determination of etiology. **Prerequisite:** MICRO 614, 615, BIOCH 623 or equivalent, or permission of instructor.
- MICRO 806** **PATHOGENESIS AND INFECTIOUS DISEASE**  
3 cr. (3 and 0) SS  
Medically important host-parasite relationships at the cellular and subcellular levels with emphasis on bacterial and viral infections in man. **Prerequisite:** MICRO 611 or permission of instructor.
- MICRO 807** **SEMINAR**  
1 cr. (1 and 0) F, S  
Topics not covered in other courses; students review literature, organize and present material. May be taken twice for credit.
- MICRO 808** **BIOTECHNOLOGY AND MEDICINE**  
3 cr. (3 and 0)  
Medical problems currently receiving attention due to the application of biotechnology to diagnosis or treatment; basic information essential to understanding the molecular biology of the disease and its diagnosis or treatment. **Prerequisite:** Permission of instructor.
- MICRO 809** **EPIDEMIOLOGICAL RESEARCH**  
(HLTH 809)  
3 cr. (3 and 0)  
Basic concepts of epidemiology with emphasis on applied aspects rather than theoretical; examples drawn from clinical practice; use of relevant PC-based computer packages required. **Prerequisite:** MTHSC 405/605 or EX ST 801 or permission of instructor.
- MICRO 811** **BACTERIAL CYTOLOGY AND PHYSIOLOGY**  
4 cr. (4 and 0) S (odd numbered years)  
Structure, chemistry and physiology of the various bacterial cell components; physiology of bacterial growth and reproduction in batch, continuous and synchronous cultures; economy of the bacterial cell including endogenous metabolism and maintenance requirements; physiology of bacterial death; regulation of enzyme and nucleic acids syntheses. **Prerequisite:** MICRO 305/605; BIOCH 423/623; MTHSC 206; or permission of instructor.
- MICRO 812** **BACTERIAL METABOLISM**  
3 cr. (3 and 0) S (even numbered years)  
Various biochemical pathways occurring in bacterial cells; fermentations of carbohydrates and related compounds and of nitrogenous organic compounds; anaerobic and aerobic respiration, including electron transport systems and oxidative phosphorylation; bacterial photosynthesis; nitrogen fixation;

biosyntheses of amino acids, purines, pyrimidines, lipids, proteins, nucleic acids and polysaccharides. **Prerequisite:** MICRO 305/605; BIOCH 423/623; MTHSC 206; or permission of instructor.

- MICRO 815** **ADVANCED MICROBIAL GENETICS**  
3 cr. (3 and 0) F  
Current developments in microbial genetics; integration of genetics and biochemistry; analysis of genetic fine structure in microorganisms; nature of bacterial variation and expression of mutations; population dynamics; physicochemical mechanisms of heredity; regulation of gene action in microorganisms; physiology and genetics of virulent and lysogenic bacteriophages. **Prerequisite:** MICRO 415/615.
- MICRO 891** **MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- MICRO 991** **DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

### Nutrition

Denzil V. Maurice, Program Coordinator, Department of Poultry Science

**Major**  
Nutrition

**Degrees**  
M.S., Ph.D.

The M.S. and Ph.D. degree programs in nutrition are interdepartmental with course work and curricula developed and offered in the departments of Animal, Dairy and Veterinary Sciences; Food Science; and Poultry Science. Applicants should have a background in basic biological sciences appropriate for advanced study in the proposed area of specialization. Students with deficiencies may be admitted if their deficiencies are corrected by completing certain undergraduate courses.

A student's program of study will include a core of basic courses in nutrition, biochemistry, statistics and physiology. Additional course work may be taken in areas of special interest as approved by the advisory committee. Thesis and nonthesis options are available. The program of study for the nonthesis option includes a minimum of 30 graduate credits with at least eight credits in 800-level nutrition courses. These eight credits may not include topical problems in nutrition or credits for seminars. The M.S. degree requires a minimum of 24 credit hours of course work and six credit hours of research.

- NUTR 601** **FUNDAMENTALS OF NUTRITION**  
3 cr. (3 and 0) F
- NUTR 625** **NUTRITION AND DIETETICS**  
4 cr. (3 and 3) F
- NUTR 626** **COMMUNITY NUTRITION**  
3 cr. (3 and 0)
- NUTR 651** **HUMAN NUTRITION**  
3 cr. (3 and 0) F, S
- NUTR 655** **NUTRITION AND METABOLISM**  
3 cr. (3 and 0) S
- NUTR 706** **NUTRITION FOR TEACHERS**  
3 cr. (3 and 0) SS  
Principles of nutrition applied to nutrition education. **Prerequisite:** Permission of instructor.



- NUTR 801 TOPICAL PROBLEMS IN NUTRITION**  
1-3 cr. (1-3 and 0)  
Topics not covered in other courses or by thesis research. Credit varies with problems selected.
- NUTR 802 SPECIAL TOPICS IN NUTRITION**  
1-3 cr. (1-3 and 0) N  
Topics of special interest or contemporary subjects not examined in other courses.
- NUTR 808 MONOGASTRIC NUTRITION**  
3 cr. (3 and 0) F  
Basic concepts and current research related to nutrient requirement and metabolism of poultry, swine and other monogastric species.  
**Prerequisite:** NUTR 401/601, 451/651 or P S 451/651.
- NUTR 809 RUMINANT NUTRITION**  
3 cr. (3 and 0) F  
Microbiological, biochemical and physiological processes involved in the synthesis of amino acids, proteins and B-vitamins; relation of these processes to utilization of proteins, lipids, and fibrous and nonfibrous feed ingredients; properties and functions of nutrients, nonprotein nitrogen compounds and growth-promoting substances for dairy cattle, beef cattle and sheep. **Prerequisite:** NUTR 401/601 or permission of instructor.
- NUTR 811 CARBOHYDRATE NUTRITION**  
2 cr. (2 and 0)  
The dietary sources, chemistry, absorption/excretion and functions of carbohydrates; the aberrations of metabolism and possible role in the etiology of degenerative diseases. **Prerequisites:** BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.
- NUTR 815 LIPID NUTRITION**  
2 cr. (2 and 0)  
Nutrition of lipids in humans and domestic animals emphasizing their source, digestion and absorption, metabolism, function, dietary needs and interrelationships. **Prerequisites:** BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.
- NUTR 816 AMINO ACIDS AND PROTEIN NUTRITION**  
2 cr. (2 and 0) F (odd numbered years)  
Nutrition of amino acids, nonprotein nitrogen and proteins related to humans and domestic animals; essentiality, interrelationships and metabolism of amino acids.
- NUTR 817 MINERAL NUTRITION**  
2 cr. (2 and 0)  
The occurrence, chemistry, absorption/excretion, and general and specific physiological functions of minerals. **Prerequisites:** BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.
- NUTR 819 VITAMIN NUTRITION**  
2 cr. (2 and 0)  
Overview of the chemistry, metabolism, physiology, digestion, absorption and excretion of the vitamins as applied to the nutrition of humans and domestic animals. **Prerequisites:**

BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.

- NUTR 820 NUTRITIONAL BIOENERGETICS**  
2 cr. (2 and 0)  
Quantitative approach to the losses of dietary energy during digestion and metabolism, and the factors governing the energetic efficiency of different biological functions in animals and man; regulation of energy balance, body temperature regulation and techniques of calorimetry. **Prerequisites:** BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.
- NUTR 851 NUTRITION SEMINAR I**  
1 cr. (1 and 0) F  
Current research and developments in nutrition. Topics, selected by the instructor and students, will come from student research and nutrition literature.
- NUTR 852 NUTRITION SEMINAR II**  
1 cr. (1 and 0) S  
Continuation of NUTR 851.
- NUTR 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- NUTR 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

*The following courses offered by various departments represent possible electives for the student in nutrition. Descriptions for all 800-level courses are under the respective departmental headings.*

- BIOCH 606 PHYSIOLOGICAL CHEMISTRY**  
3 cr. (3 and 0)
- BIOCH 815 LIPIDS AND BIOMEMBRANES**  
3 cr. (3 and 0)
- BIOCH 817 CHEMISTRY AND METABOLISM OF HORMONES**  
3 cr. (3 and 0)
- BIOCH 822 ENZYMES**  
3 cr. (3 and 0)
- P S 651 POULTRY NUTRITION**  
2 cr. (2 and 0) F (odd numbered years)

### Poultry Science

Thomas R. Scott, Chair, Department of Poultry Science

Majors	Degrees
Animal and Food Industries	M.S.
Animal Physiology	M.S., Ph.D.
Nutrition	M.S., Ph.D.

The M.S. programs in poultry science may emphasize immunology, physiology, nutrition, management, products and processing, or diseases. A thesis is required in this degree program. At the Ph.D. level, interdisciplinary study is available in nutrition and physiology. Applicants with backgrounds in the basic biological sciences and all areas of animal agriculture are accepted.

The department participates in the animal industries option of the interdisciplinary Master of Agriculture degree.



<b>P S 600</b>	<b>AVIAN PHYSIOLOGY</b> 3 cr. (3 and 0) S (even numbered years)
<b>P S 602</b>	<b>POULTRY MANAGEMENT</b> 3 cr. (2 and 2) S (odd numbered years)
<b>P S 605</b>	<b>SELECTED TOPICS</b> 1-4 cr. (1-3 and 0-3)
<b>P S 606</b>	<b>SPECIAL PROBLEMS</b> 1-3 cr. (0 and 3-9)
<b>P S 651</b>	<b>POULTRY NUTRITION</b> 2 cr. (2 and 0) F (odd numbered years)
<b>P S 653</b>	<b>POULTRY NUTRITION LABORATORY</b> 1 cr. (0 and 3) F (odd numbered years)
<b>P S 655</b>	<b>POULTRY PRODUCTS GRADING AND TECHNOLOGY</b> 3 cr. (2 and 3) S (odd numbered years)
<b>P S 658</b>	<b>AVIAN MICROBIOLOGY AND PARASITOLOGY</b> 3 cr. (3 and 0) F (even numbered years)
<b>P S 660</b>	<b>SEMINAR</b> 1 cr. (1 and 0)
<b>P S 804</b>	<b>POULTRY PATHOLOGY</b> 3 cr. (1 and 6) S (odd numbered years) Etiological agents, prophylaxis and treatment of poultry diseases; laboratory work includes experiments in bacteriology, virology, protozoology and immunology procedures emphasizing isolation and identification of disease-producing agents. <b>Prerequisite:</b> P S 458/658 or permission of instructor.
<b>P S 805</b>	<b>SEMINAR</b> 1 cr. (1 and 0) Report on special topics or original research by students, staff and visiting speakers. May be taken for a maximum of two credits.
<b>P S 825</b>	<b>IMMUNOBIOLOGY</b> 3 cr. (3 and 0) S Conceptual approach to immunobiology emphasizing the molecular and cellular aspects; classical and current literature is the major source for the discussion/lecture format. <b>Prerequisite:</b> Permission of instructor.
<b>P S 891</b>	<b>MASTER'S THESIS RESEARCH</b> Credit to be arranged.

## Zoology

James M. Colacino, Program Coordinator, Department of Biological Sciences

**Major**  
Zoology

**Degrees**  
M.S., Ph.D.

Students seeking the master's degree may select either a thesis or nonthesis option. Requirements for the thesis option include 24 semester hours of course work, six hours of research, an acceptable thesis and satisfactory performance in a final oral examination. Requirements for the nonthesis option include 36 semester hours of course work and satisfactory performance in a final comprehensive examination.

Requirements for the Ph.D. degree include written and oral comprehensive examinations, research, a dissertation and satisfac-

tory performance in a final oral defense. Although there is no required course work for the doctorate beyond 18 semester hours of research, breadth and depth of preparation in the life sciences are expected of each candidate.

<b>ZOOL 662</b>	<b>HERPETOLOGY</b> 3 cr. (2 and 3) F
<b>ZOOL 663</b>	<b>ICHTHYOLOGY</b> 3 cr. (2 and 3) S
<b>ZOOL 665</b>	<b>ORNITHOLOGY</b> 4 cr. (3 and 3) N
<b>ZOOL 803</b>	<b>POPULATION DYNAMICS</b> 4 cr. (2 and 6) N Fundamental mechanisms basic to regulation of natural animal populations; laboratory research project in population dynamics complements theory.
<b>ZOOL 810</b>	<b>BEHAVIORAL ECOLOGY</b> 3 cr. (3 and 0) N Behavior of animals and the ecological context in which various behaviors are shown; empirical and theoretical aspects of behavioral ecology at individual, population and community levels. <b>Prerequisites:</b> BIOSC 441/641 and 470/670 or permission of instructor.
<b>ZOOL 812</b>	<b>SEMINAR</b> 1 cr. (1 and 0) Review of current literature in zoology.
<b>ZOOL 815</b>	<b>PHYSIOLOGICAL ECOLOGY</b> 4 cr. (3 and 3) N Physiological and biochemical adaptations of invertebrates and vertebrates toward various natural environmental parameters; field trips acquaint students with natural macro- and micro-environments of individual species; field measurements of parameters of the environment are undertaken, and laboratory studies furnish detailed knowledge of various physiological adaptations to these parameters.
<b>ZOOL 816</b>	<b>ADVANCED ECOSYSTEM ANALYSIS</b> 4 cr. (3 and 3) N Description and analysis of ecological systems; biogeochemical, physicochemical and ecological principles, emphasizing fundamental unity of ecosystems and their abiotic environment; laboratory focuses on application of theory to actual field and laboratory research problems. <b>Prerequisites:</b> MTHSC 210 and 605; BIOSC 641 or BOT 846; or permission of instructor.
<b>ZOOL 818</b>	<b>COMMUNITY ECOLOGY</b> 4 cr. (3 and 3) N Structure and function of ecological communities, emphasizing description of natural communities and evolutionary rules by which they are organized; laboratory applies theory to field problems. <b>Prerequisites:</b> MTHSC 108 and 605, BIOSC 641 or BOT 846; or permission of instructor.



**ZOOL 835 INTERPRETIVE ELECTRON MICROSCOPY**  
3 cr. (3 and 0) N  
Cell structure as viewed through the electron microscope; characteristic structural features of cells from various tissues and from various organisms at different phylogenetic levels. **Prerequisites:** AN PH 801/BIOSC 801 or BIOSC 632 and 633 or permission of instructor.

**ZOOL 863 SPECIAL PROBLEMS**  
1-4 cr.  
Research not related to thesis. **Prerequisite:** Permission of instructor.

**ZOOL 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.

**ZOOL 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

### *School of Plant, Statistical and Ecological Sciences*

O. Joe Dickerson, Interim Lead Chair

### **Agronomy**

Doyce W. Graham, Chair, Department of Agronomy

**Major**  
Agronomy

**Degrees**  
M.S., Ph.D.

The Ph.D. and M.S. (thesis option) are research degrees that require a dissertation and thesis, respectively. The M.S. degree (thesis option) requires 24 credits of course work and six credits of research. The M.S. degree (nonthesis option), a terminal degree for students who do not plan research careers or do not plan to pursue a Ph.D. degree, requires 30 credits of course work. It may be suited for students who will pursue a career in business, educational or administrative areas that will not require research experience. The faculty participate in the plant health option of the interdisciplinary Master of Agriculture degree.

Areas of specialization normally are allied with those of the major professor. The crop sciences include plant breeding and genetics; forage systems; physiology; ecology, production and management; cellular biology and molecular genetics; and weed science. The soil sciences include chemistry; physics; microbiology and biochemistry; fertility and plant nutrition; and genesis, morphology and classification.

**AGRON 603 SOIL GENESIS AND CLASSIFICATION**  
2 cr. (1 and 3) F

**AGRON 604 SOILS AND LAND USE**  
2 cr. (1 and 3) F

**AGRON 605 PLANT BREEDING**  
3 cr. (2 and 2) S

**AGRON 607 WEED ECOLOGY AND MANAGEMENT**  
3 cr. (2 and 2) F

**AGRON 608 LAND TREATMENT OF WASTEWATER AND SLUDGES**  
(E S E 608)  
(AG E 608) 3 cr. (3 and 0) F

**AGRON 621 PRINCIPLES OF FIELD CROP PRODUCTION**  
3 cr. (3 and 0) F

**AGRON 622 MAJOR WORLD CROPS**  
3 cr. (3 and 0) S

**AGRON 623 FIELD CROPS—FORAGES**  
3 cr. (3 and 0) S

**AGRON 625 SEED SCIENCE AND TECHNOLOGY**  
3 cr. (2 and 2) S (odd numbered years)

**AGRON 626 CROPPING SYSTEMS ANALYSIS**  
(AP EC 626) 3 cr. (2 and 2) F

**AGRON 633 INTEGRATED WEED MANAGEMENT FOR AGRONOMIC AND HORTICULTURAL CROPS**  
(HORT 633) 3 cr. (2 and 2) S

**AGRON 646 SOIL MANAGEMENT**  
3 cr. (3 and 0) F

**AGRON 652 SOIL FERTILITY AND MANAGEMENT**  
3 cr. (3 and 0) S

**AGRON 653 SOIL FERTILITY LABORATORY**  
1 cr. (0 and 3) S

**AGRON 675 SOIL PHYSICS AND CHEMISTRY**  
3 cr. (2 and 3) S

**AGRON 690 BENEFICIAL SOIL ORGANISMS IN PLANT GROWTH**  
3 cr. (3 and 0) F (odd numbered years)

**AGRON 701 SOILS AND MAN**  
3 cr. (3 and 0)  
Different kinds of soils, their properties, uses, management, conservation and their relationship with the environment and other human endeavors. Not open to agronomy majors pursuing the M.S. or Ph.D. degrees.

**AGRON 801 CROP PHYSIOLOGY AND NUTRITION**  
3 cr. (3 and 0) F (odd numbered years)  
Basic concepts and physiologic aspects of growth and culture applied to crop management practices. **Prerequisites:** BIOSC 401/601 and 402/602 or equivalent.

**AGRON 802 PEDOLOGY**  
3 cr. (3 and 0) F (odd numbered years)  
Current concepts and theories in soil genesis and morphology; advanced study of soil taxonomy. **Prerequisite:** AGRON 403/603.

**AGRON 804 THEORY AND METHODS OF PLANT BREEDING**  
3 cr. (3 and 0) F (even numbered years)  
Concepts and principles of plant breeding and genetics as applied to development and maintenance of improved crop varieties; theoretical considerations of various breeding methods. **Prerequisites:** AGRON 405/605 and EX ST 801 or permission of instructor.

**AGRON 805 SOIL FERTILITY**  
3 cr. (3 and 0) S (even numbered years)  
Soil properties affecting nutrient availability and plant growth; inventory of major soil groups with reference to plant stress features; behavior of essential elements in soils in relation to plant availability; current soil fertility research. **Prerequisite:** AGRON 452 or 403 or permission of instructor.



- AGRON 806 SPECIAL PROBLEMS**  
1-3 cr. (0 and 3-9)  
Research not related to a thesis.
- AGRON 807 SOIL PHYSICS**  
4 cr. (3 and 3) F (even numbered years)  
Principles and applications of transport of water and solutes in soils emphasizing unsaturated flow phenomenon. **Prerequisite:** MTHSC 108 or equivalent.
- AGRON 808 SOIL CHEMISTRY**  
3 cr. (2 and 3) F (odd numbered years)  
Principles and theories concerning the structure and chemical properties of soil colloids, ion exchange and surface phenomena, chemical equilibria, soil acidity and oxidation-reduction reactions.
- AGRON 810 SOIL MICROBIOLOGY**  
3 cr. (3 and 0) F (even numbered years)  
Biological nitrogen fixation, mycorrhizal fungi and pesticide interactions in soils with emphasis on microbial-plant-soil relationships. **Prerequisites:** AGRON 690 or MICRO 610 and permission of instructor.
- AGRON 812 CROP ECOLOGY AND LAND USE**  
3 cr. (3 and 0) F (even numbered years)  
Concepts and factors affecting adaptation and distribution of crop plants; microclimate and crop response to environmental factors with modifications of microclimate by agricultural operations; interactions among crop plants and between weeds and crop plants under field conditions.
- AGRON 820 PESTICIDE RESIDUES IN THE ENVIRONMENT**  
3 cr. (3 and 0) S (odd numbered years)  
Accumulation, decomposition and/or attenuation of pesticides in the environment; pesticide structures and properties; sorption-desorption by soil; diffusion and transport in water; volatility and diffusion in air; chemical, bio- and photo-degradation. **Prerequisites:** Introductory courses in organic and physical chemistry or permission of instructor.
- AGRON 825 SEMINAR**  
1 cr. (1 and 0) F, S  
Special topics and original research in agronomy. Credit may be earned for more than one semester by doctoral candidates. Graded on a pass/fail basis.
- AGRON 890 SPECIAL TOPICS IN AGRONOMY**  
1-3 cr. (1-3 and 0)  
Group discussion of recent developments in agronomic research. May be repeated for a maximum of six credit hours. **Prerequisite:** Permission of instructor.
- AGRON 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- AGRON 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

## Entomology

Randall P. Griffin, Interim Chair, Department of Entomology

**Major**  
Entomology

**Degrees**  
M.S., Ph.D.

The department is dedicated to providing leadership in environmental entomology. Research programs fall into five emphasis areas: aquatic arthropod diversity, crop-insect management, genetics and biotechnology, medical and veterinary entomology, and urban entomology. Facilities of the Agricultural Experimental Station on campus and at four Research and Education Centers located in various regions of the state are available for graduate student research. In addition to teaching and research laboratories, specialized facilities within the department include laboratories for molecular genetics, tissue culture and analytical chemistry/toxicology; wet laboratories; controlled and ambient temperature insect-rearing facilities; and greenhouses.

Candidates for the M.S. degree are required to complete a thesis. The department participates in the plant health option of the interdisciplinary Master of Agriculture degree.

- ENT 601 INSECT PESTS OF ORNAMENTAL PLANTS AND SHADE TREES**  
3 cr. (2 and 3)
- ENT 604 URBAN ENTOMOLOGY**  
3 cr. (2 and 3)
- ENT 605 INSECT MORPHOLOGY**  
4 cr. (3 and 3)
- ENT 606 DISEASES AND INSECTS OF TURFGRASSES**  
(PL PA 606) 3 cr. (2 and 2)
- ENT 607 APPLIED AGRICULTURAL ENTOMOLOGY**  
4 cr. (3 and 3)
- ENT 610 INSECT TAXONOMY**  
3 cr. (1 and 6)
- ENT 612 FIELD AND MUSEUM ENTOMOLOGY**  
3 cr. (0 and 9)
- ENT 620 TOXICOLOGY OF INSECTICIDES**  
3 cr. (2 and 3)
- ENT 630 TOXICOLOGY**  
(ENTOX 630) 3 cr. (3 and 0)
- ENT 640 INSECT BEHAVIOR**  
3 cr. (2 and 3)
- ENT 655 MEDICAL AND VETERINARY ENTOMOLOGY**  
3 cr. (2 and 3)
- ENT 662 SEMINAR PRESENTATION**  
1 cr. (1 and 0)
- ENT 669 AQUATIC INSECTS**  
(W F B 669) 3 cr. (1 and 6) S (odd numbered years)
- ENT 670 INSECT PHYSIOLOGY**  
3 cr. (2 and 3)
- ENT 680 INSECT PATHOLOGY**  
3 cr. (2 and 3)
- ENT 690 INSECT BIOTECHNOLOGY**  
3 cr. (3 and 0)



- ENT 700 ENTOMOLOGY FOR TEACHERS**  
3 cr. (2 and 2) SS  
General entomology course for secondary school science teachers, with emphasis on collecting and identifying the more common insects. Additional topics include insect morphology, physiology, metamorphosis and methods available for control of destructive species. Not open to entomology majors pursuing the M.S., M.Ag. or Ph.D. degrees.  
**Prerequisite:** Permission of instructor.
- ENT 808 TAXONOMY OF IMMATURE INSECTS**  
3 cr. (1 and 6) F (odd numbered years)  
Identification of immature insects, emphasizing the Holometabola; identified collection required.
- ENT 809 SEMINAR IN ENTOMOLOGY**  
1 cr. (1 and 0)  
Current literature and research in entomology; class attendance is mandatory. May be repeated for credit. Graded on a pass/fail basis.
- ENT 810 SELECTED TOPICS**  
1-4 cr. (1-4 and 0)  
Current areas of entomological research and pest management. Course may be repeated for credit. **Prerequisite:** Permission of instructor.
- ENT 840 INSECT ECOLOGY**  
3 cr. (2 and 3) S (even numbered years)  
Principles of insect ecology, population dynamics and natural regulating mechanisms of insect populations; effect of environment on distribution and abundance of insects.
- ENT 853 APPLIED SYSTEMATICS**  
3 cr. (2 and 3) S (even numbered years)  
Application of evolutionary principles to resolution of contemporary zoological problems; legal issues and technical skills for efficient operation of international zoological information storage and retrieval system. **Prerequisite:** A taxonomic course in entomology or zoology or permission of instructor.
- ENT 860 INSECT PEST MANAGEMENT**  
3 cr. (3 and 0) S (odd numbered years)  
Application of ecological principles to the management or control of insect populations; major factors influencing insect population fluctuations; integrated systems, including biological, cultural, physical, chemical and other techniques forming a unified multifaceted approach based on applied ecology.
- ENT 863 SPECIAL PROBLEMS IN ENTOMOLOGY**  
1-3 cr. (0 and 3-9)  
Entomological research not related to thesis. **Prerequisite:** Permission of instructor.
- ENT 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- ENT 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

## Experimental Statistics

Hoke S. Hill, Jr., Chair, Faculty of Experimental Statistics

Advanced degrees in experimental statistics are not awarded. A minor is offered at the master's and doctoral levels. Courses are offered for students majoring in other disciplines. Courses to be used to satisfy a minor should be approved by this department at the beginning of the student's program. At the master's level, minimum requirements are eight credit hours of 800-level courses with one hour of EX ST 811 acceptable. At the doctoral level, minimum requirements are 12 credit hours of 800-level courses with up to four hours of EX ST 811 acceptable.

- EX ST 611 STATISTICAL METHODS FOR PROCESS DEVELOPMENT AND CONTROL**  
3 cr. (3 and 0) S
- EX ST 662 STATISTICS APPLIED TO ECONOMICS**  
3 cr. (3 and 0) F
- EX ST 801 STATISTICAL METHODS I**  
4 cr. (3 and 3) F, S  
Role and application of statistics in research; estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, mean square expectations, variance components analysis, simple and multiple linear regression and correlation, and nonparametric procedures. **Prerequisite:** Permission of instructor.
- EX ST 802 STATISTICAL METHODS II**  
3 cr. (3 and 0)  
Extended coverage of several methods introduced in EX ST 801: multiple regression model building and diagnostics, experiment design and analysis, and nonparametric methods; mixed models and repeated measures analyses; categorical data analysis; multivariate methods and sampling designs; appropriate use of statistical software emphasized. **Prerequisite:** EX ST 801.
- EX ST 803 REGRESSION AND LEAST SQUARES ANALYSIS**  
3 cr. (3 and 0) F  
Regression analysis: simple and multiple linear, curvilinear and multiple curvilinear; curve fitting; least squares and computer techniques for fitting of constants and analysis of planned experiments. **Prerequisite:** EX ST 801.
- EX ST 804 SAMPLING**  
3 cr. (3 and 0) F  
Principles of scientific sampling; finite population sampling; simple random, stratified, multi-stage and systematic sampling; optimum allocation; methods of obtaining, processing and reporting survey information; sampling as related to the environment, natural resources, and social and economic problems. **Prerequisite:** EX ST 801.
- EX ST 805 DESIGN AND ANALYSIS OF EXPERIMENTS**  
3 cr. (3 and 0) F, S  
Basic designs and analysis; data transformations; single degree of freedom, orthogonality and responses in ANOVA; covariance; response surfaces; incomplete blocks; introduction to least squares analysis of experiments; uses of standard computer programs for selected analyses. **Prerequisite:** EX ST 801.



- EX ST 811 SPECIAL PROBLEMS IN EXPERIMENTAL STATISTICS**  
1-3 cr. (0 and 2-6)  
Statistical aspects of an individualized research problem; emphasis on determining an appropriate experimental design, performing proper analyses and generating effective reports.
- EX ST 812 SELECTED TOPICS**  
1-3 cr. (1-3 and 0) S  
Selected topics in applied statistics not covered in other courses. May be repeated for different topics.

## Horticulture

Dennis R. Decoteau, Chair, Department of Horticulture

Majors	Degrees
Horticulture	M.S.
Plant Physiology	Ph.D.

The Master of Science degree is offered in floriculture, woody ornamentals, vegetable crops, pomology and turfgrass management. Candidates are required to conduct original research leading to a thesis.

The department participates in the plant health option of the interdisciplinary Master of Agriculture degree and in interdepartmental programs awarding the Doctor of Philosophy degree with a major in plant physiology, genetics and food technology. The Ph.D. program requires the performance of original research leading to a dissertation.

Research concentrations are offered in molecular biology, plant breeding and genetics, tissue culture, weed science, photomorphogenesis, postharvest physiology, stress physiology, crop production physiology, landscape design and plant nutrition. Each student's degree program is tailored to his or her professional goals with the guidance of an advisor and graduate committee. All graduate students in horticulture must select an advisor before admission. Graduate students in both the M.S. and Ph.D. degree programs are required to enroll in HORT 809 (fall semester) and 810 (spring semester).

- HORT 606 NURSERY TECHNOLOGY**  
3 cr. (2 and 3) S
- HORT 612 TURF MANAGEMENT**  
3 cr. (2 and 3) F
- HORT 615 FOLIAGE PLANTS FOR INTERIOR UTILIZATION**  
3 cr. (2 and 3) F (odd numbered years)
- HORT 633 INTEGRATED WEED MANAGEMENT FOR AGRONOMIC AND HORTICULTURAL CROPS**  
(AGRON 633)  
3 cr. (2 and 2) S
- HORT 652 TREE FRUIT CULTURE AND PHYSIOLOGY**  
3 cr. (2 and 3) F (even numbered years)
- HORT 655 SMALL FRUIT CROPS**  
3 cr. (2 and 3) F (even numbered years)
- HORT 656 VEGETABLE CROPS**  
4 cr. (3 and 3) F
- HORT 661 PROBLEMS IN LANDSCAPE DESIGN**  
4 cr. (3 and 3) S

- HORT 664 POSTHARVEST HORTICULTURE**  
3 cr. (2 and 2) F
- HORT 670 HORTICULTURE AND HUMAN WELL-BEING**  
3 cr. (2 and 3) S
- HORT 671 ADVANCED INTERNSHIP**  
1-6 cr. (0 and 2-12)
- HORT 672 GARDEN EXPERIENCES IN YOUTH DEVELOPMENT**  
2 cr. (1 and 3)
- HORT 701 HORTICULTURE: PLANT AND ENVIRONMENTAL SCIENCE**  
3 cr. (2 and 3) SS  
Scope of South Carolina horticulture and how it affects the quality of life economically and aesthetically; exploration of environmental responsibilities; demonstration of methods of teaching plant principles; includes a three-day statewide field trip to horticultural industries. Not to be taken for credit by graduate students in horticulture.
- HORT 800 TOPICS IN HORTICULTURAL SCIENCE**  
1 cr. (1 and 0)  
Timely topics in horticultural science. May be repeated for a total of four credits, as topics and instructors vary. **Prerequisite:** Permission of instructor.
- HORT 802 RESEARCH SYSTEMS IN HORTICULTURE**  
3 cr. (2 and 3) F (even numbered years)  
Current trends, developments and techniques in horticultural research. **Prerequisites:** CH 223 and 227, or CH 201 and PHYS 207, or BIOCH 210.
- HORT 804 SCIENTIFIC ADVANCES IN ORNAMENTAL HORTICULTURE**  
3 cr. (3 and 0) S (odd numbered years)  
Research and current developments in ornamental horticulture covered in scientific periodicals.
- HORT 806 POSTHARVEST PHYSIOLOGY AND HANDLING OF HORTICULTURAL CROPS**  
3 cr. (3 and 0) S (even numbered years)  
Principles, developments and research findings dealing with physiological and biochemical changes and processes occurring in horticultural plant organs after harvest; biological aspects of methods and practices relating to harvesting, handling, transportation and storage of horticultural commodities for fresh market. **Prerequisites:** BIOSC 401/601 and 402/602 or equivalent.
- HORT 809 SEMINAR I**  
1 cr. (1 and 0) F  
Current topics in horticulture prepared and presented by the student.
- HORT 810 SEMINAR II**  
1 cr. (1 and 0) S  
Continuation of HORT 809.



- HORT 812** **SPECIAL PROBLEMS IN HORTICULTURE**  
1-4 cr. (1-4 and 0)  
Research not related to a thesis. Course may be repeated for credit, but total credit may not exceed four hours. **Prerequisite:** Permission of instructor.
- HORT 813** **PHOTOMORPHOGENESIS**  
3 cr. (2 and 2)  
Regulatory role of light quality in plant development (photomorphogenesis) and its consequences in and applications for crop production. **Prerequisites:** BIOSC 401/601 and 402/602 or permission of instructor; BOT 823 preferred.
- HORT 814** **ENVIRONMENTAL PLANT STRESS PHYSIOLOGY**  
3 cr. (2 and 2)  
Environmental stresses associated with water (drought, waterlogging), temperature, light and air pollution with quantitative treatment of stress effects on plants; mechanisms by which plants may avoid, tolerate or modify stress effects on plant growth and function at the molecular, cellular and whole-plant levels. **Prerequisites:** BIOSC 401/601 and 402/602 or permission of instructor.
- HORT 851** **PLANT ANATOMY**  
(BOT 851)  
3 cr. (2 and 3) F (odd numbered years)  
See BOT 851 for description.
- HORT 891** **MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- HORT 921** **PLANT PHYSIOLOGY COLLOQUIUM**  
(BOT 921)  
1 cr. (1 and 0)  
See BOT 921 for description.
- HORT 991** **DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

## Plant Pathology

O. Joe Dickerson, Chair, Department of Plant Pathology and Physiology

**Major**  
Plant Pathology

**Degrees**  
M.S., Ph.D.

Graduate training in plant pathology is designed to help students understand principles and techniques used to diagnose plant problems; prevent and control diseases of plants; develop integrated pest management programs; engage in research involving plant disease, causal agents and host-pathogen interactions, and teach plant pathology. Current research interests include microbial ecology; molecular genetics as applied to diseases of plants, nematology and virology; diseases of field, fruit and vegetable crops; biological, integrated pest management and agrochemical approaches to plant disease control.

Candidates for the M.S. degree are required to complete research presented in a thesis form. A minimum of 24 semester hours of course work is required. Research presented as a dissertation is required of Ph.D. candidates. No specific number of credit hours of course work is required for the Ph.D. About 24 credit hours beyond the M.S. are suggested as a minimum.

The Department of Plant Pathology and Physiology participates in the plant health option of the interdisciplinary Master of Agriculture degree.

Undergraduate programs in a crop science or biology generally provide a good background for graduate work in plant pathology.

- PL PA 601** **PLANT PATHOLOGY**  
3 cr. (2 and 2)
- PL PA 602** **DISEASES OF ORNAMENTAL PLANTS**  
3 cr. (2 and 2) S
- PL PA 606** **DISEASES AND INSECTS OF TURFGRASSES**  
(ENT 606)  
3 cr. (2 and 2)
- PL PA 611** **PLANT DISEASE DIAGNOSIS**  
2 cr. (1 and 2) SS (odd numbered years)
- PL PA 651** **BACTERIAL PLANT PATHOGENS**  
3 cr. (2 and 3) F (odd numbered years)
- PL PA 656** **PLANT VIROLOGY**  
3 cr. (2 and 3) S (even numbered years)
- PL PA 658** **PLANT PARASITIC NEMATODES**  
3 cr. (2 and 3) F (even numbered years)
- PL PA 800** **ADVANCED PLANT PATHOLOGY**  
3 cr. (3 and 0) F (odd numbered years)  
Economic and social significance and history of plant pathology, host-parasite interactions (host defense mechanisms, mycotoxins, pathotoxins, mycoplasmas), ecology (mycorrhizae, pollution, soilborne plant pathogens), and disease loss and appraisal; selected pathogens used to illustrate concepts and principles; outside assignments introduce topics not covered in class. **Prerequisite:** PL PA 401.
- PL PA 801** **EPIDEMIOLOGY AND CONTROL OF PLANT DISEASES**  
3 cr. (3 and 0) S (even numbered years)  
Epidemiology and control of plant diseases, including practical and theoretical coverage of chemical, physical and biological means of plant disease control. **Prerequisites:** PL PA 401 and organic chemistry.
- PL PA 802** **SELECTED TOPICS**  
1-3 cr. (1-3 and 0-6)  
Current advances in phytopathology and physiology, diseases of specific crops, and specialized laboratory protocol. May be repeated for credit. **Prerequisite:** Permission of instructor.
- PL PA 803** **FUNGAL PLANT PATHOGENS**  
3 cr. (1 and 6) S (odd numbered years)  
Plant pathogenic fungi, including recognition of fungus disease symptoms, isolation of fungi that cause diseases, cultural features of fungi, morphological characteristics, physiological reactions to environment, disease cycles, and management of pathogens and diseases. **Prerequisites:** BIOL 104 or equivalent, PL PA 401 and BIOSC 425/625.
- PL PA 804** **PHYSIOLOGICAL PLANT PATHOLOGY**  
3 cr. (3 and 0) F (even numbered years)  
Interaction of pathogen and host in development of plant diseases; factors influencing infection; development of pathogen within host. **Prerequisites:** BIOSC 401/601 and 402/602, PL PA 401 and organic chemistry.



<b>PL PA 805</b>	<b>SPECIAL PROBLEMS IN PLANT PATHOLOGY</b> Credit to be arranged. Research not related to a thesis. <b>Prerequisites:</b> PL PA 411/611 or equivalent, and permission of instructor.
<b>PL PA 807</b>	<b>SEMINAR</b> 1 cr. (1 and 0) F, S Areas of plant pathology and plant physiology not covered by formal courses; relevant literature is reviewed, and material is organized and presented by students. Graded on a pass/fail basis.
<b>PL PA 809</b>	<b>PHYSIOLOGICAL TECHNIQUES IN PLANT PATHOLOGY</b> 2 cr. (1 and 3) S (odd numbered years) Techniques in separation science; qualitative and quantitative analysis of concern to students in plant pathology and plant physiology. <b>Prerequisite:</b> Organic chemistry or permission of instructor.
<b>PL PA 891</b>	<b>MASTER'S THESIS RESEARCH</b> Credit to be arranged.
<b>PL PA 991</b>	<b>DOCTORAL DISSERTATION RESEARCH</b> Credit to be arranged.

### Plant Physiology

N. Dwight Camper, Program Coordinator, Department of Plant Pathology and Physiology

<b>Major</b>	<b>Degree</b>
Plant Physiology	Ph.D.

The graduate program in plant physiology is interdisciplinary. Students may select courses and a major area of research from the departments of Agronomy, Biological Sciences, Forest Resources, Horticulture, and Plant Pathology and Physiology. Dissertation projects are available in the Food Science Department.

*The following courses offered by various departments represent possible electives for the student in plant physiology. Descriptions for all 800-level courses are under the respective departmental headings.*

<b>AGRON 690</b>	<b>BENEFICIAL SOIL ORGANISMS IN PLANT GROWTH</b> 3 cr. (3 and 0) F (odd numbered years)
<b>AGRON 801</b>	<b>CROP PHYSIOLOGY AND NUTRITION</b> 3 cr. (3 and 0) F (odd numbered years)
<b>AGRON 812</b>	<b>CROP ECOLOGY AND LAND USE</b> 3 cr. (3 and 0) F (even numbered years)
<b>AGRON 820</b>	<b>PESTICIDE RESIDUES IN THE ENVIRONMENT</b> 3 cr. (3 and 0) S (odd numbered years)
<b>AGRON 991</b>	<b>DOCTORAL DISSERTATION RESEARCH</b> Credit to be arranged.
<b>BIOSC 618</b> (MICRO 618) (GEN 618)	<b>BIOTECHNOLOGY I: NUCLEIC ACIDS TECHNIQUES</b> 4 cr. (2 and 4) N

<b>BOT 821</b>	<b>INORGANIC PLANT METABOLISM</b> 3 cr. (3 and 0) F (odd numbered years)
<b>BOT 822</b>	<b>ORGANIC PLANT METABOLISM</b> 3 cr. (3 and 0) S (even numbered years)
<b>BOT 823</b>	<b>PLANT GROWTH AND DEVELOPMENT</b> 3 cr. (3 and 0) F (even numbered years)
<b>BOT 824</b>	<b>MODE OF ACTION OF GROWTH SUBSTANCES</b> 4 cr. (3 and 3) S (odd numbered years)
<b>BOT 850</b>	<b>PLANT TISSUE AND CELL CULTURE</b> 3 cr. (2 and 3) F (odd numbered years)
<b>BOT 861</b>	<b>PLANT CELL BIOLOGY</b> 3 cr. (3 and 0) F (odd numbered years)
<b>BOT 921</b> (HORT 921)	<b>PLANT PHYSIOLOGY COLLOQUIUM</b> 1 cr. (1 and 0)
<b>FOR 806</b>	<b>ADVANCED SILVICULTURE — FOREST TREE GROWTH AND DEVELOPMENT</b> 3 cr. (3 and 0) F (odd numbered years)
<b>FOR 825</b>	<b>WOOD CHEMISTRY</b> 3 cr. (2 and 3) F (even numbered years)
<b>FOR 991</b>	<b>DOCTORAL DISSERTATION RESEARCH</b> Credit to be arranged.
<b>HORT 800</b>	<b>TOPICS IN HORTICULTURAL SCIENCE</b> 1 cr. (1 and 0)
<b>HORT 802</b>	<b>RESEARCH SYSTEMS IN HORTICULTURE</b> 3 cr. (2 and 3) F (even numbered years)
<b>HORT 806</b>	<b>POSTHARVEST PHYSIOLOGY AND HANDLING OF HORTICULTURAL CROPS</b> 3 cr. (3 and 0) S (even numbered years)
<b>HORT 813</b>	<b>PHOTOMORPHOGENESIS</b> 3 cr. (2 and 2)
<b>HORT 814</b>	<b>ENVIRONMENTAL PLANT STRESS PHYSIOLOGY</b> 3 cr. (2 and 2)
<b>HORT 991</b>	<b>DOCTORAL DISSERTATION RESEARCH</b> Credit to be arranged.
<b>PL PA 804</b>	<b>PHYSIOLOGICAL PLANT PATHOLOGY</b> 3 cr. (3 and 0) F (even numbered years)
<b>PL PA 809</b>	<b>PHYSIOLOGICAL TECHNIQUES IN PLANT PATHOLOGY</b> 2 cr. (1 and 3) S (odd numbered years)
<b>PL PA 991</b>	<b>DOCTORAL DISSERTATION RESEARCH</b> Credit to be arranged.
<b>PL PH 991</b>	<b>DOCTORAL DISSERTATION RESEARCH</b> Credit to be arranged.



**School of Natural and Recreational Resources**

B. Allen Dunn, Director

**Aquaculture, Fisheries and Wildlife Biology**

John R. Sweeney, Chair, Department of Aquaculture, Fisheries and Wildlife

Major	Degree
Aquaculture, Fisheries and Wildlife Biology	M.S., Ph.D.

Students desiring to pursue graduate work in aquaculture, fisheries and wildlife biology should have sound undergraduate training in the biological or related sciences. Programs of study are designed to emphasize relationships between wild animals and their changing environments and production of aquatic organisms.

Twenty-four semester hours of course work approved by the student's advisory committee, six credit hours of research (W F B 891), an acceptable thesis based upon original research and satisfactory performance in a final oral examination are required. Additional course work usually is taken in experimental statistics, biological sciences, forest resources and other related areas. The following areas of concentration are offered: aquaculture, freshwater fisheries science, marine fisheries science, conservation biology, and uplands and wetlands wildlife biology.

Research opportunities for graduate students are enhanced by cooperative programs with the S.C. Wildlife and Marine Resources Department, U.S. Fish and Wildlife Service's Cooperative Research Unit at Clemson, Savannah River Ecology Laboratory, Webb Wildlife Research Center and Waddell Mariculture Center. The department also is associated with the Institute of Wildlife and Environmental Toxicology and the Archbold Tropical Research Center. The graduate program in wildlife biology is accredited by the Southeastern Section of The Wildlife Society.

W F B 612	<b>WILDLIFE MANAGEMENT</b> 3 cr. (2 and 3) S
W F B 614	<b>WILDLIFE NUTRITIONAL ECOLOGY</b> 3 cr. (3 and 0) N
W F B 616	<b>FISHERY BIOLOGY</b> 3 cr. (2 and 3) F
W F B 630	<b>WILDLIFE CONSERVATION POLICY</b> 3 cr. (3 and 0)
W F B 650	<b>AQUACULTURE</b> 3 cr. (3 and 0) S
W F B 651	<b>FISH HATCHERY MANAGEMENT</b> 3 cr. (3 and 0) F
W F B 660	<b>WARMWATER FISH DISEASES</b> 2 cr. (2 and 0) SS (even numbered years)
W F B 662	<b>WETLAND WILDLIFE BIOLOGY</b> 3 cr. (3 and 0) F
W F B 669 (ENT 669)	<b>AQUATIC INSECTS</b> 3 cr. (1 and 6) S (odd numbered years)
W F B 712	<b>WILDLIFE CONSERVATION FOR TEACHERS</b> 2-3 cr. (2-3 and 0) Principles and practices of wildlife conservation providing an overview of wildlife diversity, ecology and management in the state. Topics include population census, wildlife identification, capture and habitat management of game

and nongame species. For in-service teachers only. **Prerequisite:** Permission of instructor.

W F B 716	<b>BIOLOGY OF FISHES FOR TEACHERS</b> 3 cr. (3 and 0) SS Biology of fishes for in-service science teachers; an overview of fish diversity, ecology, conservation and management. <b>Prerequisite:</b> Permission of instructor.
W F B 809	<b>SEMINAR IN WILDLIFE AND FISHERIES SCIENCE</b> 1 cr. (1 and 0) S Current literature and research in fisheries and wildlife sciences; one or more presentations required. May be repeated for a maximum of four credits.
W F B 810	<b>PUBLISHING IN NATURAL RESOURCE JOURNALS</b> 2 cr. (2 and 0) S (odd numbered years) Principles of preparing research manuscripts for publication in natural resource journals including searching the literature, communicating with editors, responding to reviews, publication ethics and performing peer reviews.
W F B 812	<b>CONSERVATION AND ECOLOGY OF ENDANGERED SPECIES</b> 3 cr. (3 and 0) F (even numbered years) Exploration of the processes by which species become endangered or extinct; state, federal and international strategies for species recovery. Students write a species recovery plan. <b>Prerequisite:</b> Graduate standing in a life science major or permission of instructor.
W F B 813	<b>CONSERVATION AND ECOLOGY OF WILDLIFE IN THE TROPICS</b> 3 cr. (3 and 0) N Tropical ecosystems, emphasizing the ecology and conservation of wildlife species in the neotropics; special problems associated with tropical conservation. <b>Prerequisite:</b> BIOSC 441 or equivalent.
W F B 815	<b>PRINCIPLES OF WILDLIFE BIOLOGY</b> 3 cr. (2 and 3) F (even numbered years) Theories and principles applicable to wildlife biology emphasizing upland game species.
W F B 816	<b>APPLIED WILDLIFE BIOLOGY</b> 3 cr. (2 and 3) S (even numbered years) Techniques and practices involved in management of wildlife species emphasizing upland game.
W F B 818	<b>WATERFOWL ECOLOGY AND MANAGEMENT</b> 3 cr. (2 and 3) F (odd numbered years) Identification, ecology and management of waterfowl; laboratory work includes demonstration and application of relevant waterfowl management techniques, current literature topics and field trips. <b>Prerequisite:</b> BIOSC 441/641 or W F B 412/612 or permission of instructor.



- W F B 820 SEMINAR IN AVIAN ECOLOGY**  
1 cr. (1 and 0) N  
Current issues in avian ecology; students read extensively from recent literature in avian ecology and are responsible for leading and participating in discussions of current research. May be repeated for credit. **Prerequisite:** Graduate standing in a life science or related course of study.
- W F B 830 ESTIMATION OF ANIMAL POPULATION PARAMETERS**  
3 cr. (2 and 3) S  
Techniques for sampling and estimation of parameters of free-ranging fish and wildlife populations, such as size, density, survival, natality and movement patterns; underlying assumptions, statistical properties and proper interpretation of contemporary quantitative methodology. **Prerequisite:** EX ST 801.
- W F B 840 FISH MANAGEMENT**  
3 cr. (2 and 3) F (odd numbered years)  
Principles and techniques of managing aquatic systems for recreational and/or commercial fishing, emphasizing streams, rivers, estuaries and impoundments; laboratory work includes demonstration and application of management techniques and field trips to observe management practices. **Prerequisite:** W F B 416/616 or ZOOL 463/663 or permission of instructor.
- W F B 860 DIAGNOSTIC PROCEDURES OF WARMWATER FISH DISEASES**  
2 cr. (1 and 2) SS (odd numbered years)  
Study of warmwater fish disease diagnostic procedures employing proper protocol and procedures to be followed by a fish disease diagnostician. **Corequisite:** W F B 460/660 or permission of instructor.
- W F B 861 SELECTED TOPICS**  
1-4 cr. (1-4 and 0)  
Current areas of aquaculture, fisheries and wildlife management and research. May be repeated for credit. **Prerequisite:** Permission of instructor.
- W F B 863 SPECIAL PROBLEMS IN WILDLIFE AND FISHERIES BIOLOGY**  
1-3 cr. (0 and 3-9)  
Research not related to a thesis. Credit varies with problems selected. **Prerequisite:** Permission of instructor.
- W F B 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- W F B 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

## Forest Resources

Thomas E. Wooten, Interim Chair, Department of Forest Resources

**Major**  
Forest Resources

**Degrees**  
M.F.R., M.S., Ph.D.

Enrollment in the Master of Forest Resources and Master of Science programs is open to students who have earned a baccalaureate degree in forestry, forest products or a related field. A master's degree, preferably in a forestry discipline, is required for enrollment in the Doctor of Philosophy program. The candidate may be required to satisfy undergraduate deficiencies before being admitted to full status.

The Master of Forest Resources, a nonthesis degree, requires a minimum of 36 semester hours of graduate course work with at least 18 of the required hours coming from courses numbered 700 or above.

A formal thesis is required for the Master of Science and the Doctor of Philosophy degrees. The Master of Science degree requires a minimum of 24 semester hours of course work and six hours of research. The Doctor of Philosophy degree requires a minimum of 16 semester hours of course work and 18 hours of research. For both degrees, one-half of the semester hours must be courses numbered 800 and above.

- FOR 600 PUBLIC RELATIONS IN NATURAL RESOURCES**  
3 cr. (3 and 0) S
- FOR 602 FOREST RESOURCE MEASUREMENTS II**  
3 cr. (2 and 3) S
- FOR 604 FOREST RESOURCE ECONOMICS**  
3 cr. (3 and 0) F
- FOR 606 WOOD AND WOOD FIBER IDENTIFICATION**  
2 cr. (1 and 3) F
- FOR 607 FOREST OPERATIONS**  
3 cr. (2 and 3) F
- FOR 608 AERIAL PHOTOGRAPHS IN FORESTRY**  
3 cr. (2 and 3) S
- FOR 609 MULTIPLE-USE FORESTRY**  
2 cr. (2 and 0) S
- FOR 610 SILVICULTURE I**  
4 cr. (3 and 3) S
- FOR 611 HARVESTING FOREST PRODUCTS**  
3 cr. (2 and 3) S
- FOR 612 FOREST PROTECTION**  
2 cr. (2 and 0) S
- FOR 613 INTEGRATED FOREST PEST MANAGEMENT**  
3 cr. (3 and 0) F
- FOR 614 FOREST MANAGEMENT PLANS**  
2 cr. (2 and 0) S
- FOR 615 FOREST WILDLIFE MANAGEMENT**  
3 cr. (2 and 3) S
- FOR 616 FOREST POLICY AND ADMINISTRATION**  
2 cr. (2 and 0) F



<b>FOR 617</b>	<b>FOREST RESOURCE MANAGEMENT AND REGULATION</b> 3 cr. (3 and 0) F	<b>FOR 707</b>	<b>SPECIAL PROBLEMS IN FORESTRY</b> 1-3 cr. (1-3 and 0) Directed individual study of a special problem in an applied field of forestry; written report of study results required.
<b>FOR 618</b>	<b>FOREST RESOURCE VALUATION</b> 2 cr. (2 and 0) F	<b>FOR 801</b>	<b>DATA PROCESSING IN FORESTRY PROBLEMS</b> 3 cr. (2 and 3) S Illustration, analysis and discussion of specific approaches used in forestry problems for handling, arranging and analyzing large volumes of field data and for presentation in concise, meaningful form. <b>Prerequisite:</b> Permission of instructor.
<b>FOR 620</b>	<b>FOREST PRODUCTS</b> 3 cr. (2 and 3) S	<b>FOR 802</b>	<b>ADVANCED MENSURATION</b> 3 cr. (2 and 3) S (even numbered years) Continuation of FOR 602, emphasizing specialized sampling techniques and statistical methods often required only in forestry; compilation of timber volume tables; forest survey problems. <b>Prerequisites:</b> EX ST 301 and FOR 302/602 or permission of instructor.
<b>FOR 621</b>	<b>BIOLOGY AND SILVICULTURE OF HARDWOOD FORESTS</b> 2 cr. (1 and 2) F	<b>FOR 804</b>	<b>ADVANCED FOREST ECONOMICS</b> 3 cr. (2 and 3) F (even numbered years) Examination, discussion and application of economic principles to forestry problems in use of land, labor and capital; use of theory in problems of resource allocation and efficiency in forest management. <b>Prerequisites:</b> FOR 304/604 and 418/618 or permission of instructor.
<b>FOR 622</b>	<b>FOREST PRODUCTS INTERNATIONAL TRADE</b> 3 cr. (3 and 0) F	<b>FOR 805</b>	<b>FOREST LANDSCAPE ECOSYSTEMS</b> 4 cr. (3 and 3) F (even numbered years) The three basic landscape components of soils, landform and vegetation and their interrelationships in forest ecosystems, emphasizing factors and processes of soils as interacting components with landform and vegetation. <b>Prerequisite:</b> Graduate standing or permission of instructor.
<b>FOR 623</b>	<b>CURRENT ISSUES IN NATURAL RESOURCES</b> 2 cr. (2 and 0) F, S	<b>FOR 806</b>	<b>ADVANCED SILVICULTURE—FOREST TREE GROWTH AND DEVELOPMENT</b> 3 cr. (3 and 0) F (odd numbered years) Growth and development of economically important forest tree species; structure, function, phenology and wood formation related under forest stand conditions, emphasizing manipulation of forest tree growth by cultural practice; examination of current research in growth and culture of forest trees and stands. <b>Prerequisites:</b> BIOSC 401/601 and 402/602 or permission of instructor.
<b>FOR 629</b>	<b>WOOD DESIGN</b> 3 cr. (2 and 3) F	<b>FOR 807</b>	<b>SPECIAL PROBLEMS IN FORESTRY</b> Credit to be arranged. Special problems in forestry research methods that do not directly pertain to the candidate's thesis.
<b>FOR 630</b>	<b>COMPOSITE WOOD MATERIALS</b> 3 cr. (2 and 3) F	<b>FOR 808</b>	<b>SEMINAR</b> 1 cr. (1 and 0) F, S Discussions of research and current developments in forestry; students and staff participate. May be taken up to two semesters for credit. Graded on a pass/fail basis.
<b>FOR 631</b>	<b>RECREATION RESOURCE PLANNING IN FOREST MANAGEMENT</b> 2 cr. (1 and 3) S		
<b>FOR 632</b>	<b>FOREST SITE CAPABILITY</b> 2 cr. (2 and 0) S		
<b>FOR 634</b>	<b>FOREIGN WOODS AND THEIR PROPERTIES</b> 2 cr. (1 and 3) S		
<b>FOR 635</b>	<b>PARK AND FOREST STRUCTURES</b> 2 cr. (2 and 0) F		
<b>FOR 641</b>	<b>PROPERTIES OF WOOD PRODUCTS</b> 3 cr. (3 and 0)		
<b>FOR 642</b>	<b>MANUFACTURE OF WOOD PRODUCTS I</b> 3 cr. (3 and 0)		
<b>FOR 643</b>	<b>MANUFACTURE OF WOOD PRODUCTS II</b> 3 cr. (3 and 0)		
<b>FOR 644</b>	<b>FOREST PRODUCTS MARKETING AND INTERNATIONAL TRADE</b> 3 cr. (3 and 0)		
<b>FOR 645</b>	<b>FOREST PRODUCTS AND THE ENVIRONMENT</b> 3 cr. (3 and 0)		
<b>FOR 646</b>	<b>WOOD PRODUCTS APPLICATIONS AND SPECIFICATIONS</b> 3 cr. (3 and 0)		
<b>FOR 651</b> (E S E 651) (AG E 651)	<b>NEWMAN SEMINAR AND LECTURE SERIES IN NATURAL RESOURCES ENGINEERING</b> 1 cr. (0 and 2) S, F		
<b>FOR 662</b>	<b>SILVICULTURE II</b> 3 cr. (2 and 3)		



- FOR 809 PRODUCTS BIODETERIORATION**  
2 cr. (1 and 3) F (even numbered years)  
The role of microorganisms in reducing the strength, aesthetics and value of products in service, emphasizing the deterioration of wood.
- FOR 810 FOREST LANDSCAPE ECOSYSTEMS OF THE GREAT SMOKY MOUNTAINS**  
2 cr. (1 and 1)  
Observation and measurements of species composition, community structure, soil-site relationships, land use practices within the forest ecosystems of Great Smoky Mountains National Park; field data interpreted and illustrated using ordination and classification techniques common in ecological studies. **Prerequisite:** Permission of instructor.
- FOR 811 FOREST WETLAND ECOLOGY AND MANAGEMENT**  
2 cr. (2 and 0) S  
Assessment of ecological processes and how they influence forest wetland productivity, management and regulation. **Prerequisite:** Introductory ecology or permission of instructor.
- FOR 814 ADVANCED FOREST RESOURCE MANAGEMENT AND PLANNING**  
3 cr. (3 and 0) S (odd numbered years)  
Current forest resource management and planning topics; operational emphasis on application of various quantitative tools to solve economic and management problems; advanced topics in forest regulation, forest valuation, mathematical programming and harvest scheduling, simulation, multiple-use alternatives and selected areas. **Prerequisite:** FOR 417/617 or permission of instructor.
- FOR 815 SYSTEMS PROCESSES IN NATURAL RESOURCES**  
3 cr. (2 and 3)  
Use of system thinking and system analysis to define the issues, model, simulate, and evaluate alternatives for forest landscape problems and opportunities. **Prerequisite:** Graduate standing.
- FOR 816 (PRTM 816) REMOTE SENSING AND GIS IN NATURAL RESOURCES**  
3 cr. (2 and 3) S (odd numbered years)  
Practical application of computer mapping, spatial analysis, and natural resource inventory using remote sensing and geographical information systems. **Prerequisite:** Permission of instructor.
- FOR 825 WOOD CHEMISTRY**  
3 cr. (2 and 3) F (even numbered years)  
Chemical composition of wood and related lignocellulosic substances and the chemistry of individual wood components; chemical reactions and applications of cellulose, hemicelluloses, lignin and extractives.

- FOR 826 APPLIED WOOD MECHANICS**  
3 cr. (3 and 0)  
Stress and strain of wood and wood products, orthotropic elasticity, stiffness and compliance matrices, application of elastic theory to structural systems, creep and relaxation of wood, theories and prediction of failure, analyses of layered wood composites, determination of mechanical properties and allowable stresses.
- FOR 827 WOOD PHYSICS**  
3 cr. (3 and 0)  
Thermodynamics and theories of moisture sorption in wood products; transport of moisture and heat. **Prerequisite:** Permission of instructor.
- FOR 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- FOR 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

### *School of Applied Science and Agribusiness*

Daniel B. Smith, Lead Chair

### **Agricultural and Applied Economics**

Daniel B. Smith, Chair, Department of Agricultural and Applied Economics

<b>Majors</b>	<b>Degrees</b>
Agricultural and Applied Economics	M.S.
Applied Economics	Ph.D.

Graduate work in agricultural and applied economics enables the student to attain a higher degree of specialized professional competence and to secure a greater mastery of techniques for applying quantitative economic analysis to agricultural and natural resource problems. Industry, government and universities offer challenging opportunities in research, development, education, management and other related areas for persons with advanced training.

Special emphasis in the graduate program is placed on the economics of agricultural production and marketing, economic development, analysis of government programs and policies, and statistical techniques used in solving economic and institutional problems. Flexibility is achieved through choice of elective courses and selection of an M.S. thesis or Ph.D. dissertation topic. There is no language requirement for the M.S. or Ph.D. degree.

The Department of Agricultural and Applied Economics offers courses in support of the Master of Agriculture degree, a non-thesis program.

In addition to applicants with baccalaureate degrees in agricultural economics and related programs, the department encourages applications from students who have a sound background in general economics. In many cases, such students may be admitted to full graduate status without prerequisites other than those required of all graduate students.

- AP EC 602 PRODUCTION ECONOMICS**  
3 cr. (3 and 0) F
- AP EC 603 LAND ECONOMICS**  
3 cr. (3 and 0) S
- AP EC 609 COMMODITY FUTURES MARKETS**  
3 cr. (3 and 0) F, S
- AP EC 611 REGIONAL IMPACT ANALYSIS**  
(C R D 611) 2 cr. (2 and 0) F



**AP EC 612  
(C R D 612)** **SPATIAL COMPETITION AND RURAL DEVELOPMENT**  
3 cr. (3 and 0) S

**AP EC 613** **ADVANCED REAL ESTATE APPRAISAL**  
3 cr. (3 and 0) S

**AP EC 620** **WORLD AGRICULTURAL TRADE**  
3 cr. (3 and 0) S

**AP EC 625** **AQUACULTURE ECONOMICS**  
3 cr. (3 and 0) F (alternate years)

**AP EC 626  
(AGRON 626)** **CROPPING SYSTEMS ANALYSIS**  
3 cr. (2 and 2) F

**AP EC 633** **AGRICULTURAL LAW AND RELATED ENVIRONMENTAL ISSUES**  
3 cr. (3 and 0) S

**AP EC 652** **AGRICULTURAL POLICY**  
3 cr. (3 and 0) S

**AP EC 656** **PRICES**  
3 cr. (3 and 0) S

**AP EC 660** **AGRICULTURAL FINANCE**  
3 cr. (3 and 0) S

**AP EC 675** **ECONOMICS OF WILDLIFE MANAGEMENT AND POLICY**  
3 cr. (3 and 0)

**AP EC 719** **PROFESSIONAL PROBLEMS IN AGRIBUSINESS MANAGEMENT**  
3 cr. (3 and 0) F  
Concepts and principles of agribusiness firm management; decision theory, information systems, systems analysis and organization theory applied to the organization, administration and management of agriculturally related businesses.

**AP EC 800  
(ECON 800)** **HISTORY OF ECONOMIC THOUGHT**  
3 cr. (3 and 0)  
See ECON 800 for description.

**AP EC 801  
(ECON 801)** **MICROECONOMIC THEORY**  
3 cr. (3 and 0) F  
See ECON 801 for description.

**AP EC 802  
(ECON 802)** **ADVANCED ECONOMIC CONCEPTS AND APPLICATIONS**  
3 cr. (3 and 0)  
See ECON 802 for description.

**AP EC 804  
(ECON 804)** **APPLIED MATHEMATICAL ECONOMICS**  
3 cr. (3 and 0)  
Mathematical tools needed in economic analysis. Topics include matrix algebra, differentiation, unconstrained and constrained optimization, integration and linear programming.

**AP EC 806  
(ECON 806)** **ECONOMETRICS I**  
3 cr. (3 and 0)  
Application of econometric techniques and stochastic models to economic problems. Topics include distribution theory, simple and multiple regression modeling, hypothesis testing and other issues in regression analysis.

**AP EC 807  
(ECON 807)  
(MA SC 807)** **ECONOMETRICS II**  
3 cr. (3 and 0) F  
See ECON 807 for description.

**AP EC 808  
(ECON 808)  
(MA SC 808)** **ECONOMETRICS III**  
3 cr. (3 and 0) S  
See ECON 808 for description.

**AP EC 809  
(ECON 809)** **ADVANCED NATURAL RESOURCE ECONOMICS**  
3 cr. (3 and 0) S  
Applications of economic theory to problems of natural resource management; epistemological considerations; rent theory; public and private investment criteria; benefit-cost analysis and general equilibrium management models. **Prerequisite:** AP EC 802 or permission of instructor.

**AP EC 810  
(ECON 810)** **NATURAL RESOURCES MANAGEMENT AND POLICY**  
3 cr. (3 and 0) F  
Economic, institutional and legal aspects of control and management of natural resources; concepts of economic science applied to public policy questions related to land and water resources. Specialized background in economics not necessary. **Prerequisite:** Permission of instructor.

**AP EC 811  
(ECON 811)** **ECONOMICS OF ENVIRONMENTAL QUALITY**  
3 cr. (3 and 0) F (even numbered years)  
See ECON 811 for description.

**AP EC 816  
(ECON 816)** **LABOR ECONOMICS**  
3 cr. (3 and 0)  
See ECON 816 for description.

**AP EC 817  
(ECON 817)** **ADVANCED PRODUCTION ECONOMICS**  
3 cr. (3 and 0) S  
Production economics theory in a quantitative framework; technical and economic factor-product, factor-factor and product-product relationships in single- and multiproduct firms under conditions of perfect and imperfect competition in both factor and product markets. **Prerequisite:** AP EC 804 or permission of instructor.

**AP EC 820  
(ECON 820)** **PUBLIC FINANCE**  
3 cr. (3 and 0)  
See ECON 820 for description.

**AP EC 821  
(ECON 821)** **PUBLIC CHOICE**  
3 cr. (3 and 0)  
See ECON 821 for description.

**AP EC 822  
(ECON 822)** **CONTEMPORARY PUBLIC POLICY**  
3 cr. (3 and 0) S  
Contemporary public policy, including price and resource policy, affecting rural areas; public participation, or the lack thereof, related to programs designed to implement public policy.

**AP EC 824  
(ECON 824)** **ORGANIZATION OF INDUSTRY**  
3 cr. (3 and 0)  
See ECON 824 for description.



<b>AP EC 826 (ECON 826)</b>	<b>ECONOMIC THEORY OF GOVERNMENT REGULATION</b> 3 cr. (3 and 0) See ECON 826 for description.
<b>AP EC 827 (ECON 827)</b>	<b>ECONOMICS OF PROPERTY RIGHTS</b> 3 cr. (3 and 0) See ECON 827 for description.
<b>AP EC 828 (ECON 828)</b>	<b>MARKET STRUCTURE IN AGRICULTURAL INDUSTRIES</b> 3 cr. (3 and 0) Market structure and other approaches related to agricultural marketing. Individual assignments in the student's field of interest required. <b>Prerequisite:</b> Permission of instructor.
<b>AP EC 831 (ECON 831)</b>	<b>ECONOMIC DEVELOPMENT</b> 3 cr. (3 and 0) See ECON 831 for description.
<b>AP EC 832 (ECON 832)</b>	<b>COMMUNITY AND REGIONAL ECONOMICS</b> 3 cr. (3 and 0) F Economic theory and research methods needed to understand happenings in the regional and community economy and how local and non-local decisions influence local economic change. <b>Prerequisite:</b> C R D 612 or permission of instructor.
<b>AP EC 840 (ECON 840)</b>	<b>INTERNATIONAL TRADE THEORY</b> 3 cr. (3 and 0) See ECON 840 for description.
<b>AP EC 841 (ECON 841)</b>	<b>INTERNATIONAL FINANCE</b> 3 cr. (3 and 0) See ECON 841 for description.
<b>AP EC 852</b>	<b>RESEARCH METHODS FOR AGRICULTURAL ECONOMISTS I</b> 2 cr. (2 and 0) S Linear models and their application to problems related to the economics of agriculture. Topics include the simplex method, developing farm planning LP models, solving LP problems using the MPSX computer program, parametric analysis techniques and other LP applications related to rural problems.
<b>AP EC 855 (ECON 855)</b>	<b>FINANCIAL ECONOMICS</b> 3 cr. (3 and 0) See ECON 855 for description.
<b>AP EC 881</b>	<b>INTERNSHIP IN COMMUNITY AND RESOURCE DEVELOPMENT</b> 1-6 cr. Supervised employment in an agency dealing with socioeconomic aspects, community development and/or natural resource management; monthly reports covering student's experience required. <b>Prerequisite:</b> 18 semester hours of graduate credit.
<b>AP EC 888 (ECON 888)</b>	<b>DIRECTED READINGS IN ECONOMICS</b> 1-3 cr. (1-3 and 0) See ECON 888 for description.

<b>AP EC 891</b>	<b>MASTER'S THESIS RESEARCH</b> Credit to be arranged.
<b>AP EC 899 (ECON 899)</b>	<b>SELECTED TOPICS</b> 1-3 cr. (1-3 and 0) F, S Students study selected topics under guidance of a professor. Course may be repeated for a maximum of six credits.
<b>AP EC 901 (ECON 901)</b>	<b>PRICE THEORY</b> 3 cr. (3 and 0) See ECON 901 for description.
<b>AP EC 903 (ECON 903)</b>	<b>GENERAL EQUILIBRIUM AND WELFARE THEORY</b> 3 cr. (3 and 0) S The second of a two-course sequence of advanced price theory. The first part of this course is the development of the theory of general equilibrium and the economics of welfare; the second is the capital theory and the determination of the rate of interest. <b>Prerequisite:</b> AP EC 901.
<b>AP EC 904 (ECON 904)</b>	<b>SEMINAR IN RESOURCE ECONOMICS</b> 3 cr. (3 and 0) F Special problems and recent periodical literature relating to the control, management, development and use of land and water resources in the United States and in other parts of the world. <b>Prerequisite:</b> AP EC 403/603.
<b>AP EC 905 (ECON 905)</b>	<b>ADVANCED MACROECONOMIC ISSUES</b> 3 cr. (3 and 0) See ECON 905 for description.
<b>AP EC 906 (ECON 906)</b>	<b>SEMINAR IN AREA ECONOMIC DEVELOPMENT</b> 3 cr. (3 and 0) S Recent research developments in economic development; review of research publications, journal articles and other literature; objectives, analytical techniques and procedures used in area or regional development efforts. <b>Prerequisite:</b> AP EC 806.
<b>AP EC 917 (ECON 917)</b>	<b>ADVANCED SEMINAR IN LABOR ECONOMICS</b> 3 cr. (3 and 0) See ECON 917 for description.
<b>AP EC 950 (ECON 950)</b>	<b>MONETARY ECONOMICS</b> 3 cr. (3 and 0) See Econ 950 for description.
<b>AP EC 991 (ECON 991)</b>	<b>DOCTORAL DISSERTATION RESEARCH</b> Credit to be arranged.
<b>C R D 611 (AP EC 611)</b>	<b>REGIONAL IMPACT ANALYSIS</b> 2 cr. (2 and 0) F
<b>C R D 612 (AP EC 612)</b>	<b>SPATIAL COMPETITION AND RURAL DEVELOPMENT</b> 3 cr. (3 and 0) S
<b>R S 601 (SOC 601)</b>	<b>HUMAN ECOLOGY</b> 3 cr. (3 and 0) S
<b>R S 659 (SOC 659)</b>	<b>THE COMMUNITY</b> 3 cr. (3 and 0) F



**R S 671** **DEMOGRAPHY**  
(SOC 671) 3 cr. (3 and 0) F

**R S 881** **SPECIAL PROBLEMS IN RURAL SOCIAL RESEARCH**  
1-3 cr. (0 and 2-6)  
Recent research problems and literature emphasizing research design, analysis, theoretical generalizations and application programs. May be repeated for a maximum of six credits.  
**Prerequisite:** Six semester hours of 600-level sociology or rural sociology courses or permission of instructor.

## Agricultural Education

Curtis D. White, Interim Chair, Faculty of Agricultural Education

<b>Major</b>	<b>Degree</b>
Agricultural Education	M.Ag.Ed.

The Master of Agricultural Education is a professional degree designed to enhance the human resource skills in agriculture and education. The flexible program provides a core of planning, delivery, evaluation and administrative strategies while encouraging specialization in teacher education, adult and Extension education, agricultural communications, youth development or technology transfer. Degree recipients hold positions as agriculture teachers, Extension agents, agricultural and environmental agency employees, as well as human resource development specialists in agricultural industry.

Candidates for the degree are required to:

1. plan an individual program of study in consultation with the major advisor and graduate committee;
2. complete a minimum of three semester hours in adult education, three semester hours in research methods and three semester hours of statistics;
3. complete a minimum of 12 semester hours in the major field; and
4. complete a minimum of six semester hours in an area of concentration outside the major field.

A minimum of 30 semester hours is required for the professional degree. At least one-half of the credit hours in the student's program must come from courses numbered 700 or above. The student's program of study must be approved by his or her advisory committee.

**AG ED 601** **METHODS IN AGRICULTURAL EDUCATION**  
3 cr. (2 and 3) F

**AG ED 603** **PRINCIPLES OF ADULT/EXTENSION EDUCATION**  
3 cr. (3 and 0)

**AG ED 610** **HISTORY, PHILOSOPHY AND FUTURE OF THE LAND-GRANT SYSTEM**  
3 cr. (3 and 0)

**AG ED 623** **CURRICULUM**  
2 cr. (2 and 0) S

**AG ED 625** **TEACHING AGRICULTURAL MECHANICS**  
2 cr. (1 and 3) S

**AG ED 628** **SPECIAL STUDIES IN AGRICULTURAL EDUCATION**  
1-3 cr. (1-3 and 0)

**AG ED 631** **METHODS IN ENVIRONMENTAL EDUCATION**  
3 cr. (3 and 0) SS

**AG ED 632** **VISUAL MEDIA FOR AGRIBUSINESS**  
3 cr. (2 and 3) S

**AG ED 640** **PROGRAM DEVELOPMENT IN ADULT/EXTENSION EDUCATION**  
3 cr. (3 and 0)

**AG ED 645** **EVALUATION OF ADULT/EXTENSION EDUCATION PROGRAMS**  
3 cr. (3 and 0)

**AG ED 650** **MODERN TOPICS AND ISSUES**  
3 cr. (3 and 0)

**AG ED 680** **EDUCATIONAL APPLICATIONS OF MICROCOMPUTERS**  
(THRD 680) 3 cr. (3 and 0)  
(EDF 680)

**AG ED 682** **ADVANCED EDUCATIONAL APPLICATIONS OF MICROCOMPUTERS**  
(THRD 682) 3 cr. (2 and 2)  
(EDF 682)

**AG ED 736** **INTERNSHIP: TEACHING**  
3 cr. (1 and 6) S  
Professional competency and program development through classroom and practical experiences in planning, conducting and evaluating educational programs.

**AG ED 737** **INTERNSHIP IN AGRIBUSINESS FIRMS**  
3 cr. (1 and 6) SS  
Classroom and practical experiences in selected agricultural businesses and industries. Students identify and practice entry-level competencies required in selected agribusiness and natural resource management enterprises.

**AG ED 750** **SPECIAL INSTITUTE COURSE: SELECTED TOPICS IN AGRICULTURAL EDUCATION**  
1-3 cr. (1-3 and 0)  
Subject areas organized according to institute needs. Topics vary from course to course. May be repeated for a maximum of nine credits.  
**Prerequisite:** Permission of instructor.

**AG ED 801** **SYSTEMS FOR TECHNOLOGY TRANSFER**  
3 cr. (3 and 0)  
Development of a philosophical foundation and utilization of cooperative learning strategies and techniques to disseminate effectively technological change for expanding clientele and diverse socioeconomic environments.

**AG ED 803** **EVALUATION OF INSTRUCTIONAL PROGRAMS**  
3 cr. (2 and 3) F (odd numbered years)  
Measurement and evaluation in general and as applied to agricultural and vocational education; selection and/or development and use of instruments for appraising educational outcomes of student achievement and total programs. **Prerequisite:** Permission of instructor.



- AG ED 804 SPECIAL PROBLEMS**  
3 cr. (2 and 3)  
Planning, conducting and reporting a special problem in agricultural and vocational education appropriate to students' needs.
- AG ED 805 ADMINISTRATION AND SUPERVISION IN AGRICULTURAL EDUCATION**  
3 cr. (3 and 0) S (even numbered years)  
Developing a philosophy of education including application of administrative concepts in supervising agricultural education programs. **Prerequisite:** Experience in agricultural education.
- AG ED 815 TEACHING AGRICULTURAL AND POWER MECHANICS**  
3 cr. (2 and 3) SS (odd numbered years)  
Methods of determining course content, organizing teaching modules in logical sequence, equipping shop, teaching agricultural and power mechanics to farm and agribusiness clientele, providing individualized instruction, and developing off-farm experience programs.
- AG ED 821 THEORIES AND PRACTICES OF ADULT EDUCATION**  
3 cr. (3 and 0) S  
Recent research on adult learning; a comparison of the assumptions supporting pedagogy and andragogy; emphasis on teaching adults through formal classes and community organizations. **Prerequisite:** PSYCH 201 or ED 302 or equivalent.
- AG ED 869 SEMINAR**  
1-3 cr. (1-3 and 0)  
Students and faculty review current topics in agricultural education.
- AG ED 889 RESEARCH IN EDUCATION**  
(ED 889) 3 cr. (3 and 0)  
(IN ED 889) Problem selection; types of educational research and techniques employed; use of ERIC system and computer program packages; interpretation of research findings.

### Agricultural Engineering

Joseph M. Bunn, Chair, Department of Agricultural and Biological Engineering

Major	Degrees
Agricultural Engineering	M.Engr., M.S., Ph.D

See the College of Engineering and Science for information on this program.

### Agricultural Mechanization

Joseph M. Bunn, Acting Chair, Department of Agricultural and Biological Engineering

Advanced degrees are not awarded in agricultural mechanization. Courses are offered as a minor for students majoring in other areas. The faculty participate in the agricultural mechanization and business option of the interdisciplinary Master of Agriculture degree.

- AG M 601 ENVIRONMENTAL CONTROL FOR PLANTS AND ANIMALS**  
1 cr. (1 and 0)

- AG M 602 DRAINAGE, IRRIGATION AND WASTE MANAGEMENT**  
3 cr. (2 and 3)
- AG M 603 STRUCTURES FOR PLANTS AND ANIMALS**  
2 cr. (1 and 3)
- AG M 606 MECHANICAL AND HYDRAULIC SYSTEMS**  
3 cr. (2 and 3)
- AG M 652 FARM POWER**  
3 cr. (2 and 3)
- AG M 660 FARM AND HOME UTILITIES**  
3 cr. (2 and 3)
- AG M 712 FARM MACHINERY MANAGEMENT**  
3 cr. (2 and 3)  
Selection, functional analysis and maximum utilization of existing and developing farm machinery; computer applications to programming of field operations; available capital and labor; machine size; critical field operations; growing degree days; weather; maintenance equipment, procedures and scheduling.
- AG M 771 SELECTED TOPICS IN AGRICULTURAL MECHANIZATION**  
1-3 cr. (1-3 and 0)  
Selected topics not covered in other course offerings; performance measured by oral or written reports or examinations. May be repeated for a maximum of six credits.
- AG M 781 SPECIAL PROBLEMS**  
1-3 cr. (1-3 and 0)  
Independent analysis through literature review and laboratory or field research. Requires written documentation. May be repeated for a maximum of six credits.
- AG M 851 SIMULATION OF AGRICULTURAL SYSTEMS**  
3 cr. (3 and 0)  
Synthesis and analysis of agricultural systems via computer simulation; continuous and discrete systems; philosophy of system simulation and optimization; models are used to teach working techniques, and each student builds a model of a system; computer background not required. **Prerequisite:** MTHSC 106 or permission of instructor.

### Agriculture

Jere A. Brittain, Program Coordinator, Department of Horticulture

Major	Degree
Agriculture	M.Ag.

The Master of Agriculture degree program provides graduate level, professional, nonresearch-oriented training in agriculture. It is designed to serve the graduate educational needs of working professionals in agribusiness, Extension Service personnel and other agricultural professionals. Four options are offered: agricultural economics, agricultural mechanization and business, animal industries and plant health. The departments of Agricultural and Applied Economics; Agricultural and Biological Engineering; Agronomy; Animal, Dairy and Veterinary Sciences; Entomology; Horticulture; Plant Pathology and Physiology; and Poultry Science participate in the program.



Applicants to the program are reviewed by a faculty coordinating committee and recommended for admission. Applicants with postbaccalaureate professional experience are required to submit letters of reference, written and oral expressions of professional goals, and have a minimum GPR of 2.5 overall or 2.7 for the last 60 undergraduate hours. Applicants without postbaccalaureate professional experience are required to satisfy the admission criteria for the M.S. degree program.

A minimum of 30 semester hours is required for the professional degree. At least one-half of the credit hours in the student's program must come from courses numbered 700 or above. The student's program of study must be approved by his or her advisory committee.

**Agricultural Economics.** Candidates are required to complete a minimum of 36 hours of course work: 12 hours in an area of special concentration, 12 hours of electives, with at least 12 hours in agricultural economics; and prepare and present an acceptable professional report in the form of a carefully researched, well-written paper.

**Agricultural Mechanization and Business.** This option provides a strong background in technology and business management. Students are required to complete 30 semester hours of course work.

**Animal Industries.** Students may enter the program through the departments of Animal, Dairy and Veterinary Sciences or Poultry Science. Thirty hours of course work are required and are selected specifically to meet the career goals of each student. In addition to the core courses, 12 credit hours of advanced courses relating to animal production and/or processing must be taken.

**Plant Health.** This curriculum includes courses in crop science, entomology, plant pathology, weed science and integrated pest management. Experience is provided in plant problem diagnosis and treatment in field and clinical settings. Students may enter the program through the departments of Agronomy, Entomology, Horticulture, and Plant Pathology and Physiology. A minimum of 36 semester hours is required, and the student must complete satisfactorily an internship and oral and written examinations.

The core courses listed below are required of all candidates for the Master of Agriculture degree. Descriptions for the 700- and 800-level courses are under the respective departmental headings. Core courses for each option as well as electives are available in the participating departments.

AP EC 719	<b>PROFESSIONAL PROBLEMS IN AGRIBUSINESS MANAGEMENT</b> 3 cr. (3 and 0) F
or	<b>Elective in agricultural and applied economics or business.</b>
AG ED 632	<b>VISUAL MEDIA FOR AGRIBUSINESS</b> 3 cr. (2 and 3) S
or	
ENGL 690	<b>ADVANCED TECHNICAL AND BUSINESS WRITING</b> 3 cr. (3 and 0)
EX ST 801	<b>STATISTICAL METHODS</b> 4 cr. (3 and 3) F, S

*The following courses are required in the plant health option.*

I P M 601	<b>PRINCIPLES OF INTEGRATED PEST MANAGEMENT</b> 3 cr. (3 and 0) F (even numbered years)
I P M 700	<b>INTERNSHIP IN PLANT HEALTH</b> 1-5 cr. (0 and 8-40) Professional employment under competent supervision in an approved agency or organization

dealing with the vocational or occupational aspects of plant health. During the internship, the student will submit weekly reports covering his or her experiences. A terminal report also is required. Graded on a pass/fail basis. **Prerequisites:** Graduate student standing for at least one semester, I P M 401/601 and permission of the plant health coordinator.

#### I P M 704

#### SEMINAR

1 cr. (1 and 0) F (even numbered years)  
Students and faculty review current research and development topics in integrated pest management. One or more presentations required. May be repeated for a maximum of two credits. **Prerequisite:** Permission of instructor.

#### I P M 800

#### SPECIAL PROBLEMS IN PLANT HEALTH

1-3 cr. (0 and 3-9)  
Directed individual study of a special problem in plant health; emphasis is on organizing, conducting and reporting on independent investigation. **Prerequisite:** Permission of instructor.

*In addition to the above required courses, the following courses are electives.*

AGRIC 640	<b>MICROCLIMATOLOGY</b> 3 cr. (3 or 0)
-----------	---

AGRIC 700	<b>SELECTED TOPICS</b> 3-6 cr. (0-3 and 0-9) Supervised study of a selected area in agricultural science not covered in another course; content varies based on the topic being covered. May be repeated for a maximum of six credits, but only if different topics are covered. <b>Prerequisite:</b> Permission of instructor.
-----------	---

#### Applied Economics

Daniel B. Smith, Chair, Department of Agricultural and Applied Economics

<b>Major</b>	<b>Degree</b>
Applied Economics	Ph.D.

The graduate program in applied economics utilizes the facilities and faculty of the Department of Agricultural and Applied Economics and the Department of Economics in the College of Business and Public Affairs. Students may carry out their dissertation research under the direction of a faculty member from either department.

#### Environmental Toxicology

Stephen J. Klaine, Chair, Department of Environmental Toxicology

<b>Major</b>	<b>Degrees</b>
Environmental Toxicology	M.S., Ph.D.

Environmental toxicology is the study of toxic substances in the environment and the effects of these substances and various contaminants and stressors on living systems and the physical environment. Major emphasis is placed on the metabolism of contaminants, their breakdown, fate and movement in the environment, and ecological risk assessment. The interdisciplinary program provides a strong background in basic toxicology. The program is administered jointly with the College of Engineering and Science.



Students with a baccalaureate degree in the basic and life sciences, agriculture or engineering may be admitted. Strong faculty expertise and areas of student specialization are available in wildlife toxicology, analytical toxicology and environmental chemistry, biochemical and behavioral toxicology, aquatic toxicology, ecological modeling, ecological risk assessment and biological control. Each student's research program is designed to meet his or her professional goals.

Candidates for the M.S. degree must complete 30 hours of graduate credit, including six hours of research, and write a thesis. Candidates for the Ph.D. degree must complete 18 hours of dissertation research and write a dissertation.

Graduate research programs are conducted in conjunction with The Institute of Wildlife and Environmental Toxicology (TIWET), providing a unique and innovative environment for graduate education. Research opportunities exist at permanent TIWET facilities in South Carolina, Iowa and Washington. Collaborative research opportunities exist nationally and internationally with other universities, state and federal agencies, and industrial groups.

- ENTOX 600 ENVIRONMENT AND WILDLIFE TOXICOLOGY**  
3 cr. (3 and 0)
- ENTOX 621 CHEMICAL SOURCES AND FATE IN ENVIRONMENTAL SYSTEMS**  
3 cr. (3 and 0)
- ENTOX 630 TOXICOLOGY**  
(ENT 630) 3 cr. (3 and 0)
- ENTOX 801 ADVANCED WILDLIFE TOXICOLOGY**  
3 cr. (3 and 0)  
Interactions between chemical contaminants and wildlife species, focusing on mechanisms of differential toxicities between chemicals and among species; pesticide and chemical contaminant impacts are developed with emphasis on chemical, biochemical and physiological underpinnings and assessed in terms of organismal, species and trophic responses. **Prerequisites:** ENTOX 430/630 and 421/621; or permission of instructor.
- ENTOX 806 ADVANCED ENVIRONMENTAL TOXICOLOGY**  
3 cr. (3 and 0)  
Impacts of chemical contaminants upon ecosystems; description and prediction of ecological changes resulting from a variety of human activities which involve release of xenobiotic and other chemicals into the environment. **Prerequisites:** Organic chemistry, ENT/ENTOX 430/630 and analytical chemistry; or permission of instructor.
- ENTOX 822 ANALYTICAL TOXICOLOGY LABORATORY**  
3 cr. (1 and 6)  
Laboratory instrumentation, procedures and experimental methods used for identification and quantitation of toxic substances and their transformation products in environmental and biological samples; application of these procedures in the isolation, detection and quantitation of toxicants in authentic samples. **Prerequisites:** Organic and analytical chemistry or permission of instructor; instrumental analysis recommended.

- ENTOX 830 MECHANISTIC TOXICOLOGY**  
3 cr. (3 and 0)  
Detailed biochemical toxicology: control, regulation and activity of metabolic enzymes; molecular and cellular mechanisms of toxic action; proposed mechanisms for initiation and development of cancer; mode of action and kinetics of cholinesterase inhibitors; structure/activity relationships of ion channel blockers; and biochemical and molecular biomarkers. **Prerequisite:** ENT/ENTOX 430/630.
- ENTOX 831 BIOMARKERS IN TOXICOLOGY**  
3 cr. (1 and 6)  
Methodology used in biomarker identification and evaluation of the effects of toxic substances on living systems using biomarkers in sentinel organisms and surrogate biomarkers. **Prerequisites:** Organic chemistry and biochemistry with laboratory; ENT/ENTOX 430/630 or 400/600; or permission of instructor.
- ENTOX 841 PROCEDURES AND TECHNIQUES IN ECOLOGICAL RISK ASSESSMENT**  
2 cr. (1 and 3)  
Evaluation and application of the procedures and techniques used in ecological risk assessments, including laboratory and field methods, to determine, measure and evaluate the risks to aquatic, terrestrial and avian species; focus is on impacts to biota within, and resulting from, chemical waste disposal facilities and hazardous waste sites. **Prerequisites:** CH 223, 224 and 313; EX ST 804 or 805; and ENTOX 630; or permission of instructor.
- ENTOX 852 ECOLOGICAL MODELS**  
3 cr. (2 and 3) N  
Systems analysis applied to ecology; construction of models which predict ecological consequences of stresses to the environment; frequency response analysis, energy models, information flow and transfer functions for population interactions. **Prerequisite:** A course in ecology and in computer programming or permission of instructor.
- ENTOX 854 AQUATIC TOXICOLOGY**  
3 cr. (3 and 0)  
Concepts and practices in aquatic toxicology, including physiological responses to toxic substances, bioconcentration, biomagnification, toxicity testing (algal, invertebrate and fish) and criterion development; acquaints students interested in the environmental sciences and environmental policy with basic concepts of toxicology as applied to aquatic environments. **Prerequisites:** One year of general biology, one year of general chemistry and introductory biochemistry.
- ENTOX 860 GRADUATE SEMINAR**  
1 cr. (1 and 0)  
Recent research in environmental toxicology; presentation, review and discussion of current issues by graduate students in an area of specialization selected by the instructor. May be repeated four times for credit. Graded on a pass/fail basis.



**ENTOX 861 DEPARTMENTAL SEMINAR**  
1 cr. (1 and 0)  
Presentation of current research by Department of Environmental Toxicology faculty, staff, finishing graduate students and invited speakers; students improve skills in evaluation of research plans and oral presentations, and increase awareness of literature resources and employment opportunities within the field. May be repeated four times for credit.

**ENTOX 863 SELECTED TOPICS**  
1-4 cr. (0-4 and 0-6)  
A topic in environmental toxicology not covered in another course. Topics vary with current developments in the discipline. Course may be repeated if topic and content are different. **Prerequisite:** Permission of instructor.

**ENTOX 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.

**ENTOX 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

## Food Science

James C. Acton, Chair, Department of Food Science

Majors	Degrees
Animal and Food Industries	M.S.
Plant Physiology	Ph.D.
Food Technology	Ph.D.
Nutrition	M.S., Ph.D.

A degree is not offered in this department. Degrees in the above areas with a concentration in food science are offered. Candidates for the M.S. and Ph.D. degrees must complete a research project and submit a thesis or dissertation. The M.S. degree requires a minimum of 24 credit hours of course work and six credit hours of research.

**FD SC 601 FOOD CHEMISTRY I**  
4 cr. (3 and 3) F (even numbered years)

**FD SC 602 FOOD CHEMISTRY II**  
4 cr. (3 and 3) S (odd numbered years)

**FD SC 604 FOOD PRESERVATION AND PROCESSING**  
3 cr. (3 and 0) S (even numbered years)

**FD SC 606 FOOD PRESERVATION AND PROCESSING LABORATORY**  
1 cr. (0 and 3) S (even numbered years)

**FD SC 607 QUANTITY FOOD PRODUCTION**  
2 cr. (1 and 3)

**FD SC 608 FOOD PROCESS ENGINEERING**  
4 cr. (3 and 3)

**FD SC 664 FOOD PACKAGING SYSTEMS**  
3 cr. (3 and 0)

**FD SC 666 FOOD PACKAGING SYSTEMS LABORATORY**  
1 cr. (0 and 3)

**FD SC 801 BIOCHEMICAL ASPECTS OF POULTRY PRODUCTS**  
3 cr. (2 and 3)  
Five research areas of product texture, flavor, color (appearance), nutrition and microbiology. Texture, flavor and color will be approached from a biochemical and chemical viewpoint, dealing with the meat and egg components comprising various poultry products. **Prerequisite:** PS 355/655 or FD SC 401/601 or permission of instructor.

**FD SC 810 CHEMICAL AND BIOCHEMICAL ASPECTS OF FOODS**  
4 cr. (4 and 0)  
Chemical, biochemical and functional properties of food components and their interactions in food emulsions, foams, colloids, and gel and solution states; the influences of processing on isolation, utilization and production of the constituents using techniques based on constituent properties. **Prerequisites:** BIOCH 623 and FD SC 401/601 or permission of instructor.

**FD SC 811 PHYSICAL AND THERMOPHYSICAL PROPERTIES OF FOODS**  
3 cr. (3 and 0)  
Principles involved in relating physical and thermophysical properties to food quality, including standard methods and instruments to determine texture and the relationship of physical properties to sensory evaluation; emphasis on interrelationships of chemical structure and physical properties in food processing operations. **Prerequisite:** FD SC 810 or permission of instructor.

**FD SC 812 MICROBIOLOGICAL ASPECTS OF FOOD SYSTEMS**  
3 cr. (3 and 0)  
Function and characteristics of microorganisms in the utilization and manufacture of food products; food fermentations, microbially induced chemical and physical changes, environmental aspects and production of food ingredients and resources. **Prerequisite:** MICRO 407/607 or equivalent or permission of instructor.

**FD SC 820 SELECTED TOPICS IN FOOD SCIENCE**  
1-3 cr. (1-3 and 0)  
Special topics in food science not covered in other courses. May be repeated for up to nine credits.

**FD SC 821 SELECTED TOPICS**  
1-4 cr. (0 and 3-12)  
Independent research investigation in food science areas not conducted in other courses. May be repeated for a maximum of 12 credits. **Prerequisite:** Permission of instructor.

**FD SC 851 FOOD SCIENCE SEMINAR**  
1 cr. (1 and 0)  
Current research and related developments in food science reviewed by faculty, students and invited lecturers.



**FD SC 852 FOOD SCIENCE SEMINAR**

1 cr. (1 and 0)

Continuation of FD SC 851.

**FD SC 891 MASTER'S THESIS RESEARCH**

Credit to be arranged.

**Food Technology**

Ronald L. Thomas, Program Chairman, Department of Food Science

**Major**

Food Technology

**Degree**

Ph.D.

The interdepartmental food technology doctoral program is offered by selected faculty from the departments of Agricultural and Biological Engineering; Animal, Dairy and Veterinary Sciences; Food Science; Horticulture; and Poultry Science. Applicants must have a strong background in food science and technology and related areas.

Required courses include FD TH 851, Food Technology Seminar, and FD TH 991, Doctoral Dissertation Research. Additional courses may be selected from those offered in agricultural and applied economics; agricultural engineering; animal, dairy and veterinary sciences; experimental statistics; food science; horticulture; poultry science and microbiology, as required by the student's graduate advisory committee.

**FD TH 851****FOOD TECHNOLOGY SEMINAR**

1 cr. (1 and 0) F, S

Current and ongoing research, as well as developments in food technology reviewed by faculty, students and invited lecturers. **Prerequisite:** Enrollment in the Food Technology Ph.D. program or permission of instructor.

**FD TH 991****DOCTORAL DISSERTATION RESEARCH**

Credit to be arranged.



- School of Design and Building • 72
  - Architecture • 72
  - City and Regional Planning • 74
  - Construction Science and Management • 76
- School of the Arts • 78
  - Performing Arts • 78
  - Visual Arts • 78
- School of the Humanities • 79
  - English • 79
  - History • 82
  - Languages • 84
  - Philosophy and Religion • 84
  - Professional Communication • 84

## COLLEGE OF ARCHITECTURE, ARTS AND HUMANITIES





# COLLEGE OF ARCHITECTURE, ARTS AND HUMANITIES

James F. Barker, Dean

The College of Architecture, Arts and Humanities offers advanced degrees in these areas of study.

Architecture  
City and Regional Planning  
Construction Science and Management  
English  
History  
Professional Communication  
Visual Arts

Courses are offered in art and architectural history, geography, languages, performing arts, philosophy, religion and speech to provide electives for students in other areas.

The College of Architecture, Arts and Humanities offers graduate programs in three schools: the School of Design and Building, the School of the Arts and the School of Humanities.

Graduate students in the School of Design and Building and the School of the Arts have the opportunity to study at the Charles E. Daniel Center for Building Research and Urban Studies in Genoa, Italy, which is sponsored jointly by the college and the Clemson Architectural Foundation. Emphasis is placed on studies related to this historic port city and the art and architectural heritage of the Italian setting. Studio and classroom work is enriched by visiting scholars and critics and complemented by scheduled field trips, both in Italy and continental Europe.

Courses of study in the Daniel Center, while under the jurisdiction of the related departments of the College of Architecture, Arts and Humanities, are administered and taught by the professors-in-residence. Studio work is the core of the Genoa program, whether in architecture, city and regional planning, construction science and management, or visual arts. All students undertake a history research project, conduct field studies and participate in a design seminar.

The School of Humanities is home to three graduate degree programs: the Master of Arts in English, History and Professional Communication. Faculty have been recipients of grants from agencies and foundations, such as the National Endowment for the Arts, the National Endowment for the Humanities and the Bingham Trust. They have also held Fulbright Senior Lectureships and Research Awards in many countries.

## *School of Design and Building*

### **Architecture**

Jose R. Caban, Chair, School of Architecture

**Major**  
Architecture

**Degrees**  
M.Arch., M.S.

The Master of Architecture is a professional degree program that develops proficiency in responding to contemporary architectural issues through a range of both practical and theoretical knowledge, while providing opportunities for creatively challenging the limits of the profession. Major emphasis is on design, accompanied in turn by complementary course work of a professional focus, as well as elective subjects. Complex studio design projects stress social awareness and contextual fit and are responsive to all aspects of the architectural process. Practical experience is a requisite part of the overall program, which is concluded with a thesis combining literary research with design synthesis.

Admission to the Master of Architecture program is based on the student's ability to respond effectively to the intellectual rigor and creative challenge integral to graduate architecture study. This potential is measured by demonstrated proficiency in prior academic work and Graduate Record Examinations (GRE) general test

scores, as well as creativeness of mind, motivation of spirit and maturity of purpose. Normally a personal interview is required of candidates whose application material has been reviewed favorably by the Admissions Committee. A postbaccalaureate program of preparatory study is available to qualified applicants with backgrounds in areas other than design. More detailed information concerning application procedures and requirements may be obtained by writing or calling the School of Architecture.

The duration of study required for the Master of Architecture degree is normally two academic years, and degree candidates may elect a concentration of study in either architecture, or architecture and health care. The specific study plan of each student is determined in consultation with the major advisor and is intended to reflect individual educational objectives and career goals, while assuring a comprehensive development of professional competency. Requirements for the Master of Architecture degree include 45 credits of approved course work with a minimum grade point average of 3.00, along with acceptance of a thesis of 15 hours. All candidates for graduation are required to have 1,000 hours of practical experience in an architect's office.

The Master of Science degree in architecture is a postprofessional degree program which offers the opportunity to achieve advanced learning within the discipline of architecture, and to undertake research responsive to increasingly complex challenges attendant to the built environment. This is accomplished through a foundation of course work, accompanied by directed studies within a selected area of inquiry, and followed by the critical examination of a singular aspect of architecture in a research thesis.

Admission to the Master of Science degree program is available to students who have a first professional degree in architecture, and who possess the intellectual mettle and dedication of purpose necessary to respond successfully to the rigor of advanced study and independent research. This is measured by academic proficiency in prior work, a well-reasoned plan of advanced study and GRE general test scores. A personal interview is required of all applicants whose application material has been reviewed favorably by the Admissions Committee. More information concerning application procedures and requirements may be obtained by contacting the School of Architecture.

The course work and directed studies required of the Master of Science program may be completed in one academic year, after which a variable period of time is dedicated to the research thesis. Degree candidates elect to work within one of the following areas: architecture and health care facilities, environmental issues in architecture, architecture and human perception, or theory and philosophy of architecture. A study plan is determined in consultation with the major advisor who, along with the advisory committee, periodically reviews the student's work and evaluates the research thesis. Credit requirements for the Master of Science degree consist of 24 hours of combined course work and directed studies with a minimum grade point average of 3.00, and the acceptance of a six-hour research thesis.

### **Architecture Concentration**

This inclusive course of study leading to the Master of Architecture degree affords the student an opportunity to pursue individual academic and career objectives within the context of a rigorous professionally directed architecture program. The focus of learning is the design studio, where the student is involved in a wide range of theoretical and real-world explorations. Advanced studies in technology, theory and professional practice complement design work and are accompanied by additional subjects determined in concert with the major advisor.

Although designated subjects in design and other professional studies constitute a major portion of work in this concentration, sufficient elective hours are available to establish a study plan responsive to individual interests. The choice of thesis subject provides a further opportunity for personal development.



**Architecture and Health Care Concentration**

Master of Architecture students in this specialized area of study examine issues of programming, planning and design associated with a comprehensive approach to physical and mental health care delivery systems. Studio work emphasizes the integration of physical design systems with patient care techniques. Theoretical design projects, as well as those that lead to built projects, employ both investigative research and architectural synthesis. These design studies are complemented by lectures and seminars that deal with various aspects of health care, hospital administration and the environment.

The architecture and health care concentration is demanding in the scope of its professional studies, with most of the course work designated for specific areas of learning. The thesis, which normally deals with a particular area of health care, may be project or research oriented.

- ARCH 603 THE MODERN ARCHITECTURE MOVEMENT**  
3 cr. (3 and 0)
- ARCH 604 CURRENT DIRECTIONS IN ARCHITECTURE**  
3 cr. (3 and 0)
- ARCH 605 AMERICAN ARCHITECTURAL STYLES 1650-1950**  
3 cr. (3 and 0)
- ARCH 612 ARCHITECTURAL HISTORY RESEARCH**  
3 cr. (3 and 0)
- ARCH 614 DESIGN SEMINAR\***  
3 cr. (3 and 0)
- ARCH 615 FIELD SKETCHING**  
3 cr. (0 and 6)
- ARCH 616 FIELD STUDIES IN ARCHITECTURE AND THE RELATED ARTS\***  
3 cr. (0 and 9)
- ARCH 624 PRODUCT DESIGN**  
3 cr. (0 and 9)
- ARCH 625 ENERGY IN ARCHITECTURE**  
3 cr. (3 and 0)
- ARCH 626 ARCHITECTURAL COLOR GRAPHICS**  
3 cr. (2 and 3)
- ARCH 627 ADVANCED COLOR GRAPHICS**  
3 cr. (2 and 3)
- ARCH 628 COMPUTER-AIDED DESIGN**  
3 cr. (2 and 3)
- ARCH 629 ARCHITECTURAL GRAPHICS**  
3 cr. (3 and 0)
- ARCH 630 THEORIES AND PHILOSOPHIES OF TECHNOLOGY AND ARCHITECTURE**  
3 cr. (3 and 0)
- ARCH 685 HEALTH CARE FACILITIES**  
3 cr. (3 and 0)
- ARCH 688 HEALTH CARE PROGRAMMING**  
3 cr. (3 and 0)

- ARCH 801 ARCHITECTURE SEMINAR**  
3 cr. (3 and 0)  
Contemporary issues in the architectural profession.
- ARCH 802 PHENOMENOLOGY OF ARCHITECTURE**  
3 cr. (3 and 0)  
Basic principles of phenomenological methods as they apply to the theoretical understanding of modern architecture; emphasis is on selected writings of Heidegger, Harries and Norberg-Schulz. **Prerequisite:** ARCH 803.
- ARCH 803 THEORIES OF ARCHITECTURE**  
3 cr. (3 and 0)  
Evolution of architectural theories from Vitruvius to the present; special emphasis on the writings of leading architects and theorists and the impact of these theories on architectural solutions. **Prerequisite:** Graduate status.
- ARCH 804 SEMINAR IN MODERN MASTERS**  
3 cr. (3 and 0)  
In-depth examination of one or more related groups of architects of the 20th century. Content varies from semester to semester (Kahn, Scarpa, Barrigan, Wright, Corbusier, etc.). **Prerequisite:** Graduate status.
- ARCH 805 ARCHITECTURE AND THE CITY**  
3 cr. (3 and 0)  
Seminar examining contemporary theories of urban design and the design of urban buildings; real and ideal visions of cities; their representation, archaeology and iconography (Rossi, Kries, Ungers, Venturi, Duane, etc.).
- ARCH 821 RESEARCH METHODS**  
3 cr. (3 and 0)  
The foundations and procedures of architectural research; alternate research methodologies and their philosophical and epistemological limits. **Prerequisite:** Graduate status.
- ARCH 850 ARCHITECTURE STUDIO\***  
6 cr. (0 and 18)  
Architectural design studies in the context of the Genoa urban setting. May be substituted for ARCH 853 or 854 and for ARCH 857 with permission of advisor.
- ARCH 853 ARCHITECTURE STUDIO**  
6 cr. (0 and 18)  
Architectural design studies with emphasis on selected problem issues.
- ARCH 854 ARCHITECTURE STUDIO**  
6 cr. (0 and 18)  
Architectural design studies involving structured and situational problems. **Prerequisite:** ARCH 853.
- ARCH 857 ARCHITECTURE STUDIO**  
6 cr. (0 and 18)  
Architectural design studies dealing with comprehensive problem-solving situations. **Prerequisite:** ARCH 854.

\* Offered only at the Daniel Center in Genoa, Italy.



- ARCH 858 THESIS RESEARCH**  
3 cr. (0 and 9)  
Architectural predesign inventory and analysis for the thesis project. **Prerequisite:** ARCH 854.
- ARCH 859 THESIS MANUSCRIPT**  
1-3 cr. (0 and 3-9)  
Architectural predesign synthesis of research for the thesis project. **Prerequisite:** ARCH 858.
- ARCH 881 DELIVERY OF ARCHITECTURE**  
3 cr. (3 and 0)  
Ethical, legal and business issues in the architectural profession. **Prerequisite:** Professional degree program status.
- ARCH 886 HEALTH CARE COMPONENTS**  
3 cr. (3 and 0)  
Components and service functions of physical and mental health care delivery systems and facilities.
- ARCH 890 DIRECTED STUDIES**  
1-5 cr. (1-5 and 0)  
Special topics in architecture undertaken on an individual basis with faculty guidance. **Prerequisite:** Permission of advisor.
- ARCH 891 THESIS PROJECT**  
3-9 cr. (0 and 9-27)  
Complex architectural project emphasizing design exploration and independent work. Graded on a pass/fail basis. **Prerequisites:** ARCH 857 and 858.

### City and Regional Planning

Donald L. Collins, Chair, Department of Planning and Landscape Architecture

Major	Degree
City and Regional Planning	M.C.R.P.

The two-year Master of City and Regional Planning program emphasizes land-use planning and development, environmental planning, and issues of the built and natural environments. The standard core curriculum is followed by concentrated studies in one of these areas: urban design and land-use planning and development, and environmental planning. Specialty concentrations can be tailored to doctoral programs elsewhere. Students normally choose a concentration for which their undergraduate background is best suited. No specific undergraduate area of study is required; options are available for students with or without a design background. The result is a rich cross section of students with a variety of interests. The relatively small enrollment leads to intensive faculty-student interaction. Ongoing public service and research projects provide a real-world dimension to the program. Graduates are well equipped for careers in private-sector planning and development, as well as public-sector planning and administration.

The Overseas Center for Urban Studies in Genoa, Italy, is a unique support element in the planning studies program. It provides the option of a one-semester overseas study experience in an interdisciplinary program of planning studies, design and fine arts.

### Admission Requirements

Admission to the graduate program requires the following:

1. a bachelor's degree from an accredited college or university;
2. a satisfactory academic record in the last two years of undergraduate work;

3. an on-campus interview (highly recommended);
4. three letters of recommendation from employers or personal acquaintances, with at least two from undergraduate teachers;
5. completion of the Graduate Record Examinations; and
6. one three-credit course in statistics, economics and computer applications (highly recommended).

Deficiencies in any of these areas may be remedied after enrollment in the graduate program. Postbaccalaureate status may be recommended in some cases.

### Requirements for Degree Candidacy

The two-year Master of City and Regional Planning degree requires a minimum of 54 semester hours. Nine courses, eight of three semester hours of credit and a six-credit studio, make up the core curriculum. Four approved courses of three semester hours of electives are required to complete an optional concentration. In addition, each student is required to complete an internship (or equivalent) and a terminal project/paper or thesis.

### Requirements for Awarding of a Degree

1. Thesis Option\*
  - a. A minimum of 54 hours of course work with a B average in the student's prescribed professional curriculum, including the thesis, is required.
  - b. A six- to nine-semester-hour planning thesis must be completed satisfactorily. Only those students who have been approved by the planning faculty and have performed satisfactorily on the comprehensive examination will be permitted this option.
  - c. The final oral examination requires satisfactory answers to questions concerning the student's thesis and concentration area.
2. Nonthesis Option\*
  - a. A minimum of 54 hours of course work with a B average in the student's prescribed professional curriculum is required.
  - b. An approved six-semester-hour terminal paper sequence must be completed satisfactorily. Students must perform satisfactorily on a comprehensive examination covering the core planning courses before being permitted to write the terminal paper.
  - c. The final oral examination requires satisfactory answers to questions concerning the student's terminal paper and concentration area.

**C R P 605 URBAN GENESIS AND FORM**  
3 cr. (3 and 0) N

**C R P 611 INTRODUCTION TO CITY AND REGIONAL PLANNING**  
3 cr. (3 and 0) S

**C R P 672 PLANNING PROCESS AND ADMINISTRATION**  
3 cr. (3 and 0) F

**C R P 683 SEMINAR ON PLANNING COMMUNICATION**  
3 cr. (3 and 0) S

\*Upon approval of the majority of the faculty, either a thesis or a terminal paper of up to nine semester hours may be permitted with a corresponding reduction in the required course work.



- C R P 812 CITY AND REGIONAL PLANNING THEORY**  
3 cr. (3 and 0) S  
Development of the planning practice and theories of planning process; major topics include historical evolution of planning practice in the U.S., social issues in planning, theories of planning and critiques of those theories, and ethical issues in planning practice. **Prerequisite:** Permission of instructor or department chair.
- C R P 822 URBAN SYSTEMS AND DESIGN**  
3 cr. (3 and 0) S  
Analysis of the evolution of the physical patterns of cities through research in the historical development of urban form in Europe and America within the context of prevailing social, economic and political influences; approaches to the analysis of contemporary cities through the study of 20th century planning theorists. **Prerequisite:** Permission of instructor or department chair.
- C R P 823 SOCIAL POLICY PLANNING AND DELIVERY SYSTEMS**  
3 cr. (3 and 0) S  
Concepts of planning social service delivery systems: basic principles, role of the public sector (at national, state and local levels), components of delivery systems, and methods for planning and evaluation. **Prerequisite:** Permission of instructor.
- C R P 831 PHYSICAL PLANNING STUDIO**  
3 cr. (3 and 0) F  
Working knowledge of natural systems, infrastructure systems, land use activity, social concerns, visual/spatial topics and implementation practice.
- C R P 832 PROBLEMS IN SITE PLANNING**  
3 cr. (1 and 2) F  
Advanced site planning and design concept studies developed through site projects; concentration on industrial, residential and recreational facilities; emphasis on use-specific site analysis and generation of development alternatives. **Prerequisite:** C R P 831.
- C R P 834 GEOGRAPHIC INFORMATION SYSTEMS FOR CITY AND REGIONAL PLANNING**  
3 cr. (3 and 0) S  
Introduction to geographic information systems for planning and related resource management disciplines. Topics include data development and management, spatial analysis techniques, critical review of GIS applications, needs analysis and institutional context, overview of GIS hardware and software, completion of hands-on application project.
- C R P 835 ADVANCED TOPICS IN GEOGRAPHIC INFORMATION SYSTEMS**  
3 cr. (3 and 0) F  
Seminar/laboratory devoted to development and analysis of leading edge GIS capabilities and applications; seminar focus varies from year to year, based upon developments in the GIS field and student interests. **Prerequisite:** C R P 834 or permission of instructor.
- C R P 840 SEMINAR IN COASTAL PLANNING**  
3 cr. (3 and 0) F  
Issues relating to development and conservation of coastal environments, focusing on inherent tradeoffs between growth and environmental quality; ecology and carrying capacity of coastal areas; appropriate management approaches to balance coastal resource demand. **Prerequisite:** Graduate standing.
- C R P 841 SEMINAR IN ENVIRONMENTAL PLANNING**  
3 cr. (3 and 0) S  
Current and emerging environmental issues and appropriate planning options, including population dynamics and limits to growth, entropy law, waste management and global climate change; students pursue individual research on an environmental issue of particular concern and report findings. **Prerequisite:** Graduate standing.
- C R P 853 PLANNING METHODS I: THEORY AND TECHNIQUE**  
3 cr. (0 and 9) F  
Introduction to analytic planning methods; material is drawn principally from the fields of economics, geography, regional science, and city and regional planning. **Prerequisite:** An undergraduate class in microeconomics.
- C R P 854 PLANNING METHODS II: TECHNIQUES AND APPLICATIONS**  
3 cr. (0 and 9) S  
Techniques for planning analysis, including social/economic profiles and projections, impact assessment, land use planning analysis and feasibility studies; computer modeling and simulation; students apply these techniques in studio projects. **Prerequisite:** C R P 853.
- C R P 858 RESEARCH METHODS AND THESIS PLANNING PROPOSAL**  
3 cr. (0 and 9) F  
Preliminary analysis of data to determine most advisable form of terminal presentation within thesis or nonthesis options for Master of City and Regional Planning degree. **Prerequisite:** Permission of faculty.
- C R P 859 PLANNING TERMINAL PROJECT**  
1-3 cr. (0 and 3-9) S  
Student selects, with approval of advisor, and conducts research on an individual planning problem of suitable scope. Oral, written and, where appropriate, visual presentation of solution required. Student must enroll during final semester. **Prerequisite:** C R P 858.
- C R P 860 PLANNING STUDIO\***  
3-6 cr. (0 and 9-18) F, S  
Planning studies related to the city of Genoa and its environs. May be substituted for C R P 854, 863 or 865 with approval of credit hours by major advisor.

\* Offered only at the Daniel Center in Genoa, Italy.



- C R P 863 URBAN AND METROPOLITAN PLANNING STUDIES: STUDIO**  
3-6 cr. (0 and 9-18) N  
Projects pertaining to land use, transportation, urban design, public facilities, public services, capital improvement program, etc., accomplished through individual or small group activity under guidance of planning faculty.
- C R P 866 COMPREHENSIVE PLANNING STUDIO**  
6 cr. (3 and 9) F  
Serves as a vehicle for synthesis and application of skills developed in other courses and includes participation in one or more real-world planning projects in addition to seminars and readings devoted to development of professional practice skills. **Prerequisite:** Second year C R P student or permission of instructor.
- C R P 871 GROWTH MANAGEMENT AND LEGAL ISSUES**  
3 cr. (3 and 0) S  
Basic laws and court cases relating to the comprehensive plan, implementing tools and other aspects of the planning process in the growth management context. **Prerequisites:** C R P 672 and permission of instructor or department chair.
- C R P 872 HOUSING ISSUES IN THE UNITED STATES**  
3 cr. (3 and 0) N  
Regulation, stimulation, salvage and replacement of housing through public policy administrative procedures; specific housing programs analyzed in detail.
- C R P 881 QUANTITATIVE METHODS FOR URBAN PLANNING AND POLICY**  
3 cr. (3 and 0) F  
Use of quantitative information for policy analysis in planning and related fields; topics covered include measurement construction, using descriptive and inferential statistics for policy development, and computer use in planning and related professions. **Prerequisite:** Permission of instructor or department chair.
- C R P 882 SEMINAR IN MATHEMATICAL MODELING FOR URBAN AND REGIONAL PLANNING**  
3 cr. (3 and 0) N  
Mathematical models for analysis of urban systems; predictive and estimating models; optimizing models; simulation; evaluation; theoretical knowledge applied to development of operational empirical models.
- C R P 883 TECHNIQUES FOR ANALYZING DEVELOPMENT IMPACTS**  
3 cr. (3 and 0) N  
Models and techniques for analyzing development impacts in urban areas and regions; economic, social, physical, energy and fiscal impact methods. Operational knowledge of these techniques will be developed. **Prerequisites:** C R P 881 and permission of instructor.
- C R P 889 SELECTED TOPICS IN PLANNING**  
3 cr. (3 and 0) F, S  
Topics emphasizing current literature and re-

sults of current research. May be repeated for credit. **Prerequisite:** Permission of instructor.

- C R P 890 DIRECTED STUDIES IN CITY AND REGIONAL PLANNING**  
1-6 cr. (0 and 3-18) F, S, SS  
Student pursues individual professional interests under guidance of city and regional planning program graduate faculty.
- C R P 891 PLANNING THESIS**  
1-9 cr. (0 and 1-9) S  
Student, working individually, programs a planning problem of appropriate scope and conducts research. Oral, written and, where appropriate, visual presentation of thesis required. **Prerequisite:** Permission of faculty.
- C R P 893 CITY AND REGIONAL PLANNING INTERNSHIP**  
3-6 cr. (0 and 3-18) F, S, SS  
Twelve weeks of supervised professional employment in an approved planning office or agency. Monthly reports covering student's experience required. Graded on a pass/fail basis. **Prerequisites:** Two semesters of city and regional planning or equivalent.

### Construction Science and Management

Charles Matthewson, Chair, Department of Construction Science and Management

Major	Degree
Construction Science and Management	M.C.S.M.

The Master of Construction Science and Management degree program is designed to provide students with a high level of skill and understanding in the technical areas of construction project administration and control. Substantial emphasis is placed on advanced study in the field of business, in new and emerging techniques for construction project delivery systems, and in the administration of the construction firm.

The total number of credit hours required for the Master of Construction Science and Management degree varies according to each entering student's undergraduate degree. For those who have the required undergraduate skills and knowledge, the program is 36 semester hours, of which 12 must be from the department core (C S M 860, 861, 862, 863, 864, 865 and 891). In cases where the candidate does not have the necessary prerequisite skills and knowledge, additional course work beyond the 36 semester hours is required. Each application is evaluated as to the needed additional course work. The candidate may be placed in a postbaccalaureate status if deficient courses are noted.

### Admission Requirements

1. A bachelor's degree in construction science, construction management, building construction or related areas is required. Applicants from other disciplines may be admitted but may be required to remedy any deficiencies in course work to provide the student with the needed prerequisite skills and knowledge for the construction science and management graduate program.
2. Acceptance must be granted by the Graduate School and the Department of Construction Science and Management. Graduate School acceptance is based on performance in previous undergraduate studies and a satisfactory score on the GRE. Acceptance by the department is based on performance in undergraduate studies, three letters of recommendation and acceptance by the department Graduate Admissions Committee.



### Requirements for Degree Candidacy

1. The Master of Construction Science and Management degree requires a minimum of 36 semester hours. This includes 12 semester hours of course work in the department's core and C S M 852. In cases where the candidate does not have the necessary undergraduate prerequisite skills and knowledge, additional course work beyond the 36 semester hours may be required as noted above.
2. Each student is required to have 800 hours of construction-related experience. The experience may be no older than six years from date of enrollment in the CSM graduate program.

### Requirements for Awarding of a Degree

1. Thesis Option
  - a. A minimum of 36 semester hours of course work with a B average in the student's prescribed curriculum, including thesis, is required.
  - b. A thesis on a construction-related topic must be completed satisfactorily. Up to nine semester hours of thesis credit may be taken. Thesis credit is included as part of the department's core. Approval must be received from the student's advisor prior to selecting the thesis option.
  - c. Performance on a written comprehensive examination covering the student's program of study must be satisfactory.
  - d. Performance on a final oral examination relating to the student's thesis and program of study must be satisfactory. The student must pass the written comprehensive examination prior to taking the oral examination.
2. Nonthesis Option
  - a. A minimum of 36 semester hours of course work with a B average in the student's prescribed curriculum is required.
  - b. Performance on a written comprehensive examination covering the student's program of study must be satisfactory.
  - c. Performance on a final oral examination relating to the student's program of study must be satisfactory. The student must pass the written comprehensive examination prior to taking the oral examination.

**C S M 655**      **REDUCING ADVERSARIAL RELATIONS IN CONSTRUCTION**  
3 cr. (3 and 0)

**C S M 850**      **INTERNATIONAL CONSTRUCTION\***  
6 cr. (0 and 18)  
Building industries in foreign countries and the methods of managing the construction process within them. This course will be taken by M.C.S.M. students at the Genoa Center in Italy.

**C S M 852**      **CONSTRUCTION MANAGEMENT RESEARCH**  
3 cr. (2 and 4)  
Research methodology applied to the construction industry. **Prerequisite:** Permission of instructor.

**C S M 860**      **FINANCIAL PLANNING AND ANALYSIS**  
3 cr. (3 and 0)  
Theory of financial management as it relates to the financial problems faced by the building construction firm. **Prerequisite:** Permission of instructor.

**C S M 861**      **CONSTRUCTION CONTROL SYSTEMS**  
3 cr. (3 and 0)  
Design and administration of the quality assurance program for large and complex construction projects. **Prerequisite:** Permission of instructor.

**C S M 862**      **PERSONNEL MANAGEMENT AND NEGOTIATIONS**  
3 cr. (3 and 0)  
The role of management and unions in the construction industry. Topics include contract negotiation, collective bargaining, dispute resolution and management for productivity improvement. **Prerequisite:** Permission of instructor.

**C S M 863**      **ADVANCED SCHEDULING**  
3 cr. (1 and 6)  
Analysis and control of complex construction projects using advanced techniques for scheduling and resource leveling. **Prerequisite:** Permission of instructor.

**C S M 864**      **COST ANALYSIS AND MARKETING**  
3 cr. (1 and 6)  
Advanced techniques for cost analysis and their use in marketing construction management, design-build or single-contract project delivery services. **Prerequisite:** Permission of instructor.

**C S M 865**      **PROJECT MANAGEMENT**  
3 cr. (3 and 0)  
Theory of project administration and control with special emphasis on the role and responsibilities of the resident project representative and the project manager. **Prerequisite:** Permission of instructor.

**C S M 871**      **ARCHITECTURAL STRUCTURES**  
3 cr. (3 and 0)  
Examination and evaluation of structural systems with emphasis on the compatibility and constraints exerted on architectural design goals. **Prerequisites:** C S M 302 and permission of instructor.

**C S M 877**      **ADVANCED ARCHITECTURAL ACOUSTICS**  
3 cr. (3 and 0)  
Advanced study of acoustics with emphasis on individual research into design for good hearing and sound control in and around buildings, and applications to design studio work and thesis project; ray tracing for ITDGs, analog models using lasers, evaluations of completed buildings and rigorous analysis of case studies. **Prerequisites:** C S M 403 and permission of instructor.

**C S M 878**      **LIGHTING FOR ARCHITECTURE**  
3 cr. (3 and 0)  
Interrelationships among the many fields that constitute lighting and its impact on building form, materials and spatial use; the potential contribution of daylight and electric light to human response and performance. **Prerequisites:** C S M 403 and permission of instructor.

\* Offered only at the Daniel Center in Genoa, Italy.



- C S M 881 PROFESSIONAL SEMINAR**  
3 cr. (3 and 0)  
New and emerging methods for management of the construction or construction-related firm.  
**Prerequisite:** Permission of instructor.
- C S M 890 DIRECTED STUDIES**  
3-6 cr.  
Special topics not covered in other courses; emphasis is on field studies, research activities and current developments in building science.  
**Prerequisite:** Permission of instructor.
- C S M 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.  
With the approval of the advisory committee, the student carries on independent research and analysis. The thesis is presented orally and in writing and in strict compliance with the guidelines of the Graduate School.
- C S M 899 CONSTRUCTION SCIENCE AND MANAGEMENT INTERNSHIP**  
No credit  
Consists of 800 hours of verifiable construction-related experience; experience may be no older than six years from date of enrollment in CSM graduate program. Graded on a credit/no credit basis; a letter grade is not given; will not count toward a graduate degree.

### *School of the Arts*

#### **Performing Arts**

Clifton S.M. Egan, Chair, Department of Performing Arts

Advanced degrees are not awarded in performing arts. Courses are offered to provide electives for students in other areas.

- THEA 672 IMPROVISATION: INTERPRETING AND DEVELOPING TEXTS**  
3 cr. (3 and 0)
- THEA 699 INDEPENDENT STUDIES**  
1-3 cr. (1-3 and 0)

#### **Visual Arts**

John T. Acorn, Chair, Department of Art

**Major**  
Visual Arts

**Degree**  
M.F.A.

The Master of Fine Arts degree is the terminal degree within the areas of visual arts. The program offers concentration in the studio areas of drawing, painting, printmaking, ceramics, photography and sculpture. Interdisciplinary projects are encouraged within the department and college. The primary goal of the program is the development of each student to a high degree of professional competence.

#### **Admission Requirements**

The graduate program in visual arts leading to the Master of Fine Arts degree admits a limited number of talented and creative candidates on a competitive basis as follows:

1. The candidate must have a bachelor's degree from an accredited college or university with a major in visual arts, liberal arts, fine arts or architecture. Especially well-qualified persons may be accepted from other degree backgrounds.

2. A satisfactory academic record in the last 60 major credit hours of undergraduate work is required.
3. A portfolio documentation of candidate's creative work must be submitted. Portfolio should represent between 15-20 works, the majority of which should represent the chosen field of study. This portfolio, which may include slides, photographs, films, other documentation or the original work, is reviewed by the Admissions Committee, composed of members of the faculty of the Department of Art. Upon acceptance of the past accomplishments of the candidate, a personal interview is arranged.
4. Letters of recommendation are preferred from former major professors, producing artists or professional acquaintances. Other letters of recommendation will be accepted.
5. A statement of intent regarding applicant's interest and direction in pursuing the graduate degree must be submitted.

#### **Requirements for Degree Candidacy**

The prospective candidate must have a review of his or her work at the end of each semester. It will be determined at this time if the student should continue or whether additional study is required at either the undergraduate or graduate level.

The candidate must complete 30 hours and a full-time residency during the second year of study.

#### **Requirements for Awarding of a Degree**

Students are required to complete the following:

1. a minimum of 45 credit hours with a B average or above in the student's professional curriculum, including 36 hours of ART 600- and 800-level courses, and nine hours in the history of art; and
2. a 15-credit-hour thesis culminating in satisfactory completion of a written documentary of the "thesis exhibition" and an oral examination by the Graduate Committee.

- ART 605 ADVANCED DRAWING**  
3 cr. (0 and 6)
- ART 607 ADVANCED PAINTING**  
3 cr. (0 and 6)
- ART 609 ADVANCED SCULPTURE**  
3 cr. (0 and 6)
- ART 611 ADVANCED PRINTMAKING**  
3 cr. (0 and 6)
- ART 613 ADVANCED PHOTOGRAPHY**  
3 cr. (0 and 6)
- ART 615 ADVANCED GRAPHIC DESIGN**  
3 cr. (0 and 6)
- ART 617 ADVANCED CERAMIC ARTS**  
3 cr. (0 and 6)
- ART 620 SELECTED TOPICS IN ART**  
3 cr. (0 and 6)
- ART 690 DIRECTED STUDIES**  
1-5 cr. (0 and 2-10)
- ART 805 VISUAL ARTS SEMINAR ON THEORIES AND PRACTICE I**  
3 cr. (3 and 0)  
Issues related to the practice of the artist, emphasizing theories and criticism of contemporary art.



- ART 806 VISUAL ARTS SEMINAR ON THEORIES AND PRACTICE II**  
3 cr. (3 and 0)  
Continuation of ART 805.
- ART 840 VISUAL ARTS STUDIO**  
3-6 cr. (0 and 9-18)  
Studio work in visual arts with adjunct lectures and gallery tours. May be substituted for ART 800-level visual arts studio.
- ART 850 VISUAL ARTS STUDIO**  
3 cr. (0 and 9)  
Concentrated and advanced work in ceramics, drawing, painting, printmaking, sculpture, photography, graphic design or multimedia. **Prerequisite:** Permission of department chair or instructor.
- ART 851 VISUAL ARTS STUDIO**  
3-6 cr. (0 and 9)  
Continuation of ART 850. May be repeated for maximum of six credits. **Prerequisite:** Permission of department chair or instructor.
- ART 870 VISUAL ARTS STUDIO**  
6 cr. (0 and 16)  
Advanced theory; directed research in art criticism; applied work in ceramic arts, drawing, painting, sculpture, photography, graphic design or multimedia. **Prerequisite:** Permission of department chair or instructor.
- ART 871 VISUAL ARTS STUDIO**  
3-6 cr. (0 and 8-16)  
Continuation of ART 870. May be repeated for maximum of six credits. **Prerequisite:** Permission of department chair or instructor.
- ART 880 VISUAL ARTS STUDIO**  
3-15 cr. (0 and 6-30)  
Continuation of ART 871. May be repeated for maximum of 15 credits. **Prerequisite:** Permission of department chair or instructor.
- ART 891 MASTER'S THESIS RESEARCH**  
3-15 cr. (0 and 6-30)  
May be repeated for maximum of 15 credits. **Prerequisite:** Permission of department chair or instructor.

*No degrees are offered in art and architectural history. Courses are offered to provide electives for students in other areas.*

- A A H 611 DIRECTED RESEARCH IN ART HISTORY I**  
3 cr. (3 and 0)
- A A H 612 DIRECTED RESEARCH IN ART HISTORY II**  
3 cr. (3 and 0)
- A A H 617 STUDIES IN THE ART AND ARCHITECTURE OF THE ANCIENT WORLD I**  
3 cr. (3 and 0)
- A A H 618 STUDIES IN THE ART AND ARCHITECTURE OF THE ANCIENT WORLD II**  
3 cr. (3 and 0)
- A A H 619 STUDIES IN THE ART AND ARCHITECTURE OF THE EARLY MIDDLE AGES**  
3 cr. (3 and 0)

- A A H 620 STUDIES IN THE ART AND ARCHITECTURE OF THE LATE MIDDLE AGES**  
3 cr. (3 and 0)
- A A H 623 STUDIES IN THE ART AND ARCHITECTURE OF THE RENAISSANCE I**  
3 cr. (3 and 0)
- A A H 624 STUDIES IN THE ART AND ARCHITECTURE OF THE RENAISSANCE II**  
3 cr. (3 and 0)
- A A H 625 ARCHITECTURE OF THE TECHNOLOGICAL REVOLUTION: 1685-1865**  
3 cr. (3 and 0)
- A A H 627 EIGHTEENTH CENTURY VISUAL ARTS**  
3 cr. (3 and 0)
- A A H 628 NINETEENTH CENTURY VISUAL ARTS**  
3 cr. (3 and 0)
- A A H 629 STUDIES IN THE ART AND ARCHITECTURE OF INDIA AND THE FAR EAST**  
3 cr. (3 and 0)
- A A H 630 TWENTIETH CENTURY ART I**  
3 cr. (3 and 0)
- A A H 632 TWENTIETH CENTURY ART II**  
3 cr. (3 and 0)
- A A H 815 ART AND ARCHITECTURAL HISTORY SEMINAR I**  
3 cr. (3 and 0)  
Particular aspect of period of art/architectural history. **Prerequisite:** Permission of instructor.
- A A H 816 ART AND ARCHITECTURAL HISTORY SEMINAR II**  
3 cr. (3 and 0)  
Continuation of A A H 815.

### *School of the Humanities*

#### **English**

Frank L. Day, Chair, Department of English

**Major**  
English

**Degree**  
M.A.

An applicant for the M.A. degree in English must present at least 12 semester credits of undergraduate English courses beyond the sophomore level; for the M.Ed. degree in secondary education with emphasis in English, an applicant must present at least nine. Entrance credits should include one course each above the sophomore level in Shakespeare and in English and American literature; students deficient in these may seek provisional admission.

M.A. students complete 25 semester credits of approved graduate courses and write a thesis, which may be developed with the approval of the Graduate Committee, from any interest area covered by the M.A. program. The nonthesis option requires 37 credits. All English M.A. students must demonstrate a reading knowledge of an approved foreign language.

At the core of the M.A. program is a 10-hour requirement, including ENGL 800 and one course from each of the following groups:



1. British literature — ENGL 805, 808, 811, 814 or an appropriate 831;
2. American literature — ENGL 820, 823 or an appropriate 831;
3. Language and composition — ENGL 685 (required of graduate teaching assistants), 801, 802, 803, 832, 835, 837 or an appropriate 831.

M.Ed. students in secondary education with emphasis in English complete a total of 37 graduate credits, including ENGL 685 and 800.

Candidates for the M.A. and M.Ed. degrees also must demonstrate proficiency in composition and pass a comprehensive oral examination.

ENGL 600	THE ENGLISH LANGUAGE 3 cr. (3 and 0)
ENGL 601	GRAMMAR SURVEY 3 cr. (3 and 0)
ENGL 603	THE CLASSICS IN TRANSLATION 3 cr. (3 and 0)
ENGL 604	CLASSICAL DRAMA 3 cr. (3 and 0)
ENGL 605	STUDIES IN ENGLISH LITERATURE TO 1700 3 cr. (3 and 0)
ENGL 606	STUDIES IN ENGLISH LITERATURE SINCE 1700 3 cr. (3 and 0)
ENGL 607	THE MEDIEVAL PERIOD 3 cr. (3 and 0)
ENGL 608	CHAUCE 3 cr. (3 and 0)
ENGL 609	THE EARLIER ENGLISH RENAISSANCE 3 cr. (3 and 0)
ENGL 610	DRAMA OF ENGLISH RENAISSANCE 3 cr. (3 and 0)
ENGL 611	SHAKESPEARE 3 cr. (3 and 0)
ENGL 612	STUDIES IN SHAKESPEARE 3 cr. (3 and 0)
ENGL 613	THE LATER ENGLISH RENAISSANCE 3 cr. (3 and 0)
ENGL 614	MILTON 3 cr. (3 and 0)
ENGL 615	THE RESTORATION AND EIGHTEENTH CENTURY 3 cr. (3 and 0)
ENGL 616	THE ROMANTIC PERIOD 3 cr. (3 and 0)
ENGL 617	THE VICTORIAN PERIOD 3 cr. (3 and 0)
ENGL 618	THE ENGLISH NOVEL 3 cr. (3 and 0)
ENGL 622	STUDIES IN AMERICAN LITERATURE I 3 cr. (3 and 0)

ENGL 623	STUDIES IN AMERICAN LITERATURE II 3 cr. (3 and 0)
ENGL 624	STUDIES IN AMERICAN LITERATURE III 3 cr. (3 and 0)
ENGL 625	THE AMERICAN NOVEL 3 cr. (3 and 0)
ENGL 626	SOUTHERN LITERATURE 3 cr. (3 and 0)
ENGL 630	MODERN DRAMA 3 cr. (3 and 0)
ENGL 631	MODERN POETRY 3 cr. (3 and 0)
ENGL 632	MODERN FICTION 3 cr. (3 and 0)
ENGL 633	THE ANGLO-IRISH LITERARY TRADITION 3 cr. (3 and 0)
ENGL 634	ENVIRONMENTAL LITERATURE 3 cr. (3 and 0)
ENGL 635	LITERARY CRITICISM 3 cr. (3 and 0)
ENGL 636	FEMINIST LITERARY CRITICISM 3 cr. (3 and 0)
ENGL 637	DIRECTED STUDIES 1-3 cr. (1-3 and 0)
ENGL 645	FICTION WORKSHOP 3 cr. (3 and 0)
ENGL 646	POETRY WORKSHOP 3 cr. (3 and 0)
ENGL 647	PLAYWRITING WORKSHOP 3 cr. (3 and 0)
ENGL 650	FILM GENRES 3 cr. (2 and 3)
ENGL 651	FILM THEORY AND CRITICISM 3 cr. (2 and 3)
ENGL 652	GREAT DIRECTORS 3 cr. (2 and 3)
ENGL 653	SEXUALITY AND THE CINEMA 3 cr. (2 and 3)
ENGL 655	AMERICAN HUMOR 3 cr. (3 and 0)
ENGL 659	ADVANCED SPECIAL TOPICS IN LANGUAGE, LITERATURE OR CULTURE 3 cr. (3 and 0)
ENGL 682	AFRICAN AMERICAN FICTION AND NONFICTION 3 cr. (3 and 0)
ENGL 683	AFRICAN AMERICAN POETRY, DRAMA AND FILM 3 cr. (3 and 0)
ENGL 685	COMPOSITION FOR TEACHERS 3 cr. (3 and 0)



<b>ENGL 690</b>	<b>ADVANCED TECHNICAL AND BUSINESS WRITING</b> 3 cr. (3 and 0)	<b>ENGL 814</b>	<b>TOPICS IN VICTORIAN AND MODERN BRITISH LITERATURE</b> 3 cr. (3 and 0) Principal works in verse and prose from c. 1832 to present.
<b>ENGL 691</b>	<b>CLASSICAL RHETORIC</b> 3 cr. (3 and 0)	<b>ENGL 820</b>	<b>TOPICS IN AMERICAN LITERATURE TO 1865</b> 3 cr. (3 and 0) Significant authors; works in poetry and prose; literary-intellectual movements such as Puritanism, the enlightenment, romanticism and transcendentalism from c. 1607-1865.
<b>ENGL 692</b>	<b>MODERN RHETORIC</b> 3 cr. (3 and 0)	<b>ENGL 823</b>	<b>TOPICS IN AMERICAN LITERATURE SINCE 1865</b> 3 cr. (3 and 0) Significant authors; works in poetry and prose; literary-intellectual movements such as realism, naturalism, modernism and postmodernism from 1865 to the present.
<b>ENGL 695</b>	<b>TECHNICAL EDITING</b> 3 cr. (3 and 0)	<b>ENGL 831</b>	<b>SPECIAL TOPICS</b> 3 cr. (3 and 0) Topics not covered in other courses.
<b>ENGL 700</b>	<b>CHILDREN'S LITERATURE FOR TEACHERS</b> 3 cr. (3 and 0) Literature for preschool through junior high.	<b>ENGL 832</b>	<b>TOPICS IN SCIENTIFIC, TECHNICAL AND BUSINESS WRITING</b> 3 cr. (3 and 0) Seminar courses in areas such as professional editing and publishing, writing for government and industry, teaching technical writing, and writing for journals, magazines and newspapers.
<b>ENGL 701</b>	<b>LITERATURE FOR TEACHERS</b> 3 cr. (3 and 0) Literary studies of special interest to secondary school teachers.	<b>ENGL 835</b>	<b>TOPICS IN LITERARY CRITICISM</b> 3 cr. (3 and 0) Principal statements of literary critics from the classical era to the present.
<b>ENGL 702</b>	<b>WRITING PROJECTS</b> 3 cr. (3 and 0) Exchange and development of methods for teaching writing that have a firm theoretical foundation.	<b>ENGL 837</b>	<b>TOPICS IN LINGUISTICS</b> 3 cr. (3 and 0) Concepts of traditional and modern grammarians; development of English language.
<b>ENGL 800</b>	<b>INTRODUCTION TO RESEARCH</b> 1 cr. (1 and 0) Literary history and research; use of libraries and bibliographical tools; exposition of scholarship. Required of all candidates for the Master of Arts degree and Master of Education degree with a concentration in secondary education, English.	<b>ENGL 840</b>	<b>SELECTED TOPICS</b> 3 cr. (3 and 0) Tutorial work in linguistics or American, British or European literature not offered in other courses. <b>Prerequisite:</b> Permission of director of graduate studies.
<b>ENGL 801</b>	<b>TOPICS IN COMPOSITION</b> 3 cr. (3 and 0) Principal theories and practices in modern grammar, stylistics and semantics related to teaching composition.	<b>ENGL 850</b>	<b>RESEARCH AND STUDIES IN SCIENTIFIC, BUSINESS AND TECHNICAL WRITING</b> 3 cr. (3 and 0) Theories of professional communication and methods of inquiry; readings and research into the ways that the writing of professionals creates new knowledge and affects the daily life of others; research methods emphasize humanistic inquiry. <b>Prerequisite:</b> Graduate standing.
<b>ENGL 802</b>	<b>TOPICS IN LITERARY GENRES</b> 3 cr. (3 and 0) Principal literary genres.	<b>ENGL 851</b>	<b>SEMINAR IN PROFESSIONAL WRITING</b> 3 cr. (3 and 0) Advanced seminar in the principles and practice of writing and editing documents for government, industry and the sciences; students produce projects suitable for publication, typically chosen from document design, scientific or technical journalism, and public policy writing. <b>Prerequisite:</b> Graduate standing.
<b>ENGL 803</b>	<b>TOPICS IN RHETORICAL THEORY</b> 3 cr. (3 and 0) Major rhetorical theories, figures and historical movements.		
<b>ENGL 805</b>	<b>TOPICS IN MEDIEVAL LITERATURE</b> 3 cr. (3 and 0) Principal works in verse and prose from c. 1100-1500.		
<b>ENGL 808</b>	<b>TOPICS IN RENAISSANCE AND RESTORATION LITERATURE</b> 3 cr. (3 and 0) Principal works in verse and prose from c. 1500-1700.		
<b>ENGL 811</b>	<b>TOPICS IN NEOCLASSIC AND ROMANTIC LITERATURE</b> 3 cr. (3 and 0) Principal works in verse and prose from c. 1700-1832.		



- ENGL 853 VISUAL COMMUNICATIONS**  
3 cr. (3 and 0)  
Understanding the language of images used in textual and extratextual communication; theories of perception, methods of visual persuasion, gender analysis, and cognitive and aesthetic philosophies of visual rhetoric. **Prerequisite:** Graduate standing.
- ENGL 854 TEACHING PROFESSIONAL WRITING**  
3 cr. (3 and 0)  
Teaching professional writing and examining theories and practices of written, graphic and oral communication; students prepare course descriptions, rationales and syllabi for teaching various forms of business, scientific and technical writing. **Prerequisite:** Graduate standing.
- ENGL 885 COMPOSITION THEORY**  
3 cr. (3 and 0)  
Teaching college-level courses, stressing contemporary composition theory, research and practice. **Prerequisite:** Graduate standing.
- ENGL 886 COMPOSITION PRACTICUM**  
1 cr. (1 and 0)  
Problems in teaching Composition I and Composition II, with focus on translating theoretical concepts into creating assignments, designing curriculum and grading. Two-semester sequence to be taken fall and spring of teaching assistantship year. Does not count toward degree. **Prerequisites:** Graduate teaching assistantship and English 885 or equivalent.
- ENGL 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- ENGL 892 MASTER'S PROJECT**  
1-3 cr.  
Required for the nonthesis option of the M.A. in professional communication; completion of course requires writing a document for the professional world and keeping a log or journal as a record of the project; student presents the project to advisor(s). Credit to be arranged. A maximum of three credits may be counted toward the degree.
- SPCH 664 ADVANCED ORGANIZATIONAL COMMUNICATION**  
3 cr. (3 and 0)

## History

H. Roger Grant, Chair, Department of History

**Major**  
History

**Degree**  
M.A.

The M.A. in history requires 30 credits in courses numbered 600 or above that must be divided as follows: (1) three credits in historiography (HIST 881); (2) a minimum of nine additional credits in courses numbered between 800 and 894, excluding independent study (HIST 885) and graduate thesis research (HIST 891); (3) a minimum of 12 elective credits in graduate courses selected with the approval of the director of the graduate program; (4) a minimum of six credits in graduate thesis research (HIST 891). Additionally, the student must write a thesis acceptable to

the department and must demonstrate reading knowledge of a foreign language. A final examination, which may be written or oral or a combination of the two forms, is required of all candidates.

Students holding an assistantship in the Department of History who receive a grade lower than B in any graduate course may have their assistantships terminated.

With departmental consent, any 600-level course in history may be repeated one time for credit.

- HIST 600 STUDIES IN UNITED STATES HISTORY**  
3 cr. (3 and 0)
- HIST 638 PROBLEMS IN AFRICAN HISTORIOGRAPHY AND METHODOLOGY**  
3 cr. (3 and 0)
- HIST 640 STUDIES IN LATIN AMERICAN HISTORY**  
3 cr. (3 and 0)
- HIST 650 STUDIES IN ANCIENT HISTORY**  
3 cr. (3 and 0)
- HIST 660 STUDIES IN BRITISH HISTORY**  
3 cr. (3 and 0)
- HIST 670 STUDIES IN EARLY EUROPEAN HISTORY**  
3 cr. (3 and 0)
- HIST 671 STUDIES IN MODERN EUROPEAN HISTORY**  
3 cr. (3 and 0)
- HIST 692 STUDIES IN DIPLOMATIC HISTORY**  
3 cr. (3 and 0)
- HIST 693 STUDIES IN SOCIAL HISTORY**  
3 cr. (3 and 0)
- HIST 694 STUDIES IN COMPARATIVE HISTORY**  
3 cr. (3 and 0)
- HIST 695 STUDIES IN THE HISTORY OF IDEAS**  
3 cr. (3 and 0)
- HIST 696 STUDIES IN LEGAL HISTORY**  
3 cr. (3 and 0)
- HIST 697 STUDIES IN THE HISTORY OF SCIENCE AND TECHNOLOGY**  
3 cr. (3 and 0)
- HIST 700 UNITED STATES THROUGH THE CIVIL WAR**  
3 cr. (3 and 0)  
Problems in United States history through 1865 with attention given to bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate students. May be repeated with permission of graduate program director.
- HIST 710 UNITED STATES SINCE 1865**  
3 cr. (3 and 0)  
Problems in United States history since 1865 with attention given to bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate students. May be repeated with permission of graduate program director.



- HIST 720 SOUTHERN HISTORY**  
3 cr. (3 and 0)  
Problems in Southern history with attention given to bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate students. May be repeated with permission of graduate program director.
- HIST 760 BRITISH HISTORY**  
3 cr. (3 and 0)  
Problems in the history of Great Britain and the British Empire with attention given to bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate students. May be repeated with permission of graduate program director.
- HIST 770 EUROPE TO THE 18TH CENTURY**  
3 cr. (3 and 0)  
Problems in European history to 1700 with attention given to bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate students. May be repeated with permission of graduate program director.
- HIST 775 EUROPE SINCE THE 18TH CENTURY**  
3 cr. (3 and 0)  
Problems in European history since 1700 with attention given to bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate students. May be repeated with permission of graduate program director.
- HIST 790 HISTORICAL AREA STUDIES**  
3 cr. (3 and 0)  
Problems in the history of Africa, Asia, Latin America or the Middle East with attention given to bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate students. May be repeated with permission of graduate program director.
- HIST 800 SEMINAR IN UNITED STATES HISTORY**  
3 cr. (3 and 0)  
Training in historical research and writing. May be repeated for credit with approval of graduate program director.
- HIST 830 SEMINAR IN ASIAN HISTORY**  
3 cr. (3 and 0)  
Training in historical research and writing with focus on Asian history. May be repeated for credit with approval of graduate program director.
- HIST 840 SEMINAR IN LATIN AMERICAN HISTORY**  
3 cr. (3 and 0)  
Training in historical research and writing with focus on Latin American history. May be repeated for credit with approval of graduate program director.
- HIST 860 SEMINAR IN BRITISH HISTORY**  
3 cr. (3 and 0)  
Training in historical research and writing. May be repeated for credit with approval of graduate program director.
- HIST 870 SEMINAR IN EUROPEAN HISTORY**  
3 cr. (3 and 0)  
Training in historical research and writing. May be repeated for credit with approval of graduate program director.
- HIST 880 SPECIAL TOPICS IN HISTORY**  
3 cr. (3 and 0)  
Training in historical research and writing. May be repeated for credit with approval of graduate program director.
- HIST 881 HISTORIOGRAPHY**  
3 cr. (3 and 0)  
Seminar discussion of contemporary approaches and methodologies used by historians; exploration of current debates over major issues confronting the discipline of history.
- HIST 885 INDEPENDENT STUDY**  
3 cr. (3 and 0)  
Critical study of a historical topic, selected according to needs of student and with approval of graduate program director. May be repeated for credit with the approval of the graduate program director.
- HIST 887 ARCHIVAL MANAGEMENT: AN INTRODUCTION**  
3 cr. (3 and 0)  
Introduction to basic concepts of archival theory and management.
- HIST 888 HISTORICAL AND TEXTUAL EDITING**  
3 cr. (3 and 0)  
Practical, intensive course introduces techniques for handling archival materials and preparing scholarly editions.
- HIST 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- HIST 893 PRACTICUM IN ARCHIVAL MANAGEMENT**  
3 cr. (0 and 9)  
Hands-on experience in the operations of an archival program, including acquisitions, arrangements, descriptions, conservation and reference service. **Prerequisite:** HIST 887 or permission of instructor.
- HIST 894 PRACTICUM IN HISTORICAL EDITING**  
3 cr. (3 and 0)  
Practicum for applying methodologies learned in introductory editing course to a specific body of original sources such as family correspondence, diaries or journals in order to become a historical editor. **Prerequisite:** HIST 888.
- GEOG 601 STUDIES IN REGIONAL GEOGRAPHY**  
3 cr. (3 and 0)
- GEOG 610 GEOGRAPHY OF THE AMERICAN SOUTH**  
3 cr. (3 and 0)
- GEOG 620 HISTORICAL GEOGRAPHY OF THE UNITED STATES**  
3 cr. (3 and 0)



**GEOG 700 TOPICS IN GEOGRAPHY**  
3 cr. (3 and 0)  
Topic in geography such as world regions, American minorities, the historical geography of the United States or the geography of South Carolina. Restricted to elementary and secondary school teachers. May be repeated for credit with departmental permission. **Prerequisite:** Permission of department.

**GEOG 710 TEACHING GEOGRAPHY**  
3 cr. (3 and 0)  
Investigates world regions as a set of problems posed to teachers of geography; comparative analysis of basic geographic concepts. Oriented to public school teachers of geography.

## Languages

Samuel C. King, Chair, Department of Languages

Advanced degrees are not awarded in languages. Courses are offered to provide electives for students in other areas.

**FR 699 SELECTED TOPICS IN FRENCH LITERATURE**  
3 cr. (3 and 0)

**GER 698 INDEPENDENT STUDY**  
1-3 cr. (1-3 and 0)

**SPAN 699 SPANISH LITERATURE, LANGUAGE AND CULTURE**  
3 cr. (3 and 0)

*Two special courses are offered in French and German for graduate students preparing for the language examination.*

**FR 151 FRENCH FOR GRADUATE STUDENTS**  
3 cr. (3 and 0)

**GER 151 GERMAN FOR GRADUATE STUDENTS**  
3 cr. (3 and 0)

## Philosophy and Religion

Stuart Silvers, Chair, Department of Philosophy and Religion

Advanced degrees are not awarded in philosophy and religion. Courses are offered to provide electives for students in other areas.

**PHIL 601 STUDIES IN THE HISTORY OF PHILOSOPHY**  
3 cr. (3 and 0)

**PHIL 602 TOPICS IN PHILOSOPHY**  
3 cr. (3 and 0)

**PHIL 825 ADVANCED STUDIES IN THE PHILOSOPHY OF SCIENCE**  
3 cr. (3 and 0) F  
Inquiry into the conceptual foundations of empirical science, in particular, the often tacit presuppositions of substantive and methodological assumptions shared by a scientific community.

**REL 601 STUDIES IN BIBLICAL LITERATURE AND RELIGION**  
3 cr. (3 and 0)

**REL 602 STUDIES IN RELIGION**  
3 cr. (3 and 0)

## Professional Communication

Martin Jacobi, Program Coordinator, Department of English

<b>Major</b>	<b>Degree</b>
Professional Communication	M.A.

The Department of English offers a Master of Arts degree in professional communication. The program combines work in theory and research with a comprehensive emphasis on written, oral and visual communication. It prepares graduate students as professional and technical communicators in industry and government and as teachers of professional communication in two-year colleges. In addition, the program provides the background necessary for students who plan to pursue a Ph.D. in rhetoric or technical communication.

This degree is designed for students with strong writing skills from all academic disciplines. The program accommodates students with undergraduate majors in technical and scientific fields, as well as those with humanities and business degrees.

The Campbell Chair in Technical Communication, the Pearce Center for Professional Communication and the Effective Technical Communication program in engineering constitute a network of professors enabling students to work in professional communication in a variety of academic disciplines. The program also uses Clemson's expertise in agriculture and natural resources, architecture, city and regional planning, engineering, textiles, and basic science and technologies. The Document Design Laboratory has Macintosh and IBM capabilities, and students have access to the newest computing hardware and software, including word processing, desktop publishing and graphic design.

The M.A. in professional communication requires 30 credit hours beyond the B.A. or B.S. degree, to be distributed as follows:

1. Core courses include professional writing, organizational communication, visual communication and research in professional communication.
2. Students choose four or five electives from a list of recommended courses, structuring the program to meet their professional goals.
3. Candidates must demonstrate a reading knowledge of a foreign language and pass a qualifying examination on a reading list before undertaking the required thesis or project.
4. Students choose either to write a thesis based on research and a thorough analysis of a problem in professional communication, offering a solution; or complete a project to write a document for the professional world and keep a log or journal as a record of the project's progress.

Applicants must hold a degree in any field from an accredited college or university, with a 3.0 GPR on a four-point scale; submit a satisfactory score on the GRE general test; submit two letters of recommendation from individuals familiar with the candidate's academic work and/or work experience; and submit a brief resumé and an autobiographical essay of not more than 500 words discussing educational goals and demonstrating proficiency for a writing program.

Courses for this program are offered by the Department of English.



## School of Accountancy and Legal Studies • 86

Accounting • 86

## School of Business and Leadership • 87

Applied Economics • 87

Business Administration • 87

Economics • 91

Finance • 94

Graphic Communications • 94

Industrial Management • 94

Management Science • 97

Marketing • 98

## School of Social Science • 98

Applied Sociology • 98

Political Science • 100

Psychology • 102

## COLLEGE OF BUSINESS AND PUBLIC AFFAIRS





# COLLEGE OF BUSINESS AND PUBLIC AFFAIRS

Jerry E. Trapnell, Dean

The College of Business and Public Affairs offers advanced degrees in these areas of study.

Accounting  
Applied Economics\*  
Applied Sociology  
Business Administration  
Economics  
Industrial Management  
Management Science\*\*  
Psychology  
Public Administration

Courses are offered in finance, graphic communication, hospital administration, law, marketing and political science to provide electives for students in other areas.

Graduate programs in the College of Business and Public Affairs provide a wide range of opportunities for professional careers in business, industry, government and education.

Several graduate programs are offered jointly or in cooperation with other departments and universities. The applied economics program is a cooperative effort with the Department of Agricultural and Applied Economics in the College of Agriculture, Forestry and Life Sciences. The Master of Public Administration is taught jointly by faculty from the Department of Political Science at Clemson University and the Department of Government and International Relations at the University of South Carolina. The Ph.D. program in management science is administered jointly by the Department of Management and the Department of Mathematical Sciences in the College of Engineering and Science.

## School of Accountancy and Legal Studies

### Accounting

Alan J. Winters, Director, School of Accountancy and Legal Studies

Major	Degree
Accounting	M.P.Acc.

The Master of Professional Accountancy degree program prepares students for positions in industrial, commercial, governmental, financial or public accounting. The program requires 33 semester hours and is open to students with appropriate backgrounds. The program accommodates both full- and part-time students. In addition to the on-campus program, the program is offered to part-time students at the University Center in Greenville, S.C. Full-time students are able to complete the program in one calendar year. Part-time students on campus or in Greenville can complete the program in three years. The program recognizes the rapid pace of change in accounting resulting from technological advances in managing data, the theory and practice of management, and increases in the volume and scope of authoritative pronouncements from the FASB, SEC and IRS. The program is accredited by the American Assembly of Collegiate Schools of Business.

\* This program is a cooperative effort between the Department of Agricultural and Applied Economics (College of Agriculture, Forestry and Life Sciences) and the Department of Economics. The Department of Agricultural and Applied Economics is responsible administratively for the Ph.D. program, and the degree is awarded by the College of Agriculture, Forestry and Life Sciences.

\*\* This program is administered jointly by the Department of Management and the Department of Mathematical Sciences (College of Engineering and Science). The Ph.D. degree is awarded by the College of Business and Public Affairs.

Applicants should hold a bachelor's degree from an institution whose scholastic rating is acceptable to the Graduate Admissions Committee of the School of Accountancy and Legal Studies. Admission to the program is based on academic record and score on the Graduate Management Admission Test (GMAT). Letters of recommendation and relevant work experience also may be considered. Applicants should have completed a basic business core of at least 30 semester hours, as well as the following accounting prerequisites: Intermediate Accounting (at least six semester hours), Cost Accounting (three semester hours), Tax (three semester hours), Auditing (three semester hours) and Accounting Information Systems (three semester hours). An undergraduate microcomputer applications course is highly recommended.

ACCT 604	<b>INDIVIDUAL TAXATION</b> 3 cr. (3 and 0)
ACCT 801	<b>CONTEMPORARY FINANCIAL ACCOUNTING THEORY</b> 3 cr. (3 and 0) Development of accounting theory from its origin to the present; currently advocated pronouncements of professional accounting societies. <b>Prerequisite:</b> ACCT 302 or equivalent.
ACCT 802	<b>AUDITING SEMINAR</b> 3 cr. (3 and 0) In-depth study of the Professional Standard for independent auditors; taught by the case method and includes a discussion of contemporary auditing problems and cases. <b>Prerequisite:</b> ACCT 415 or equivalent.
ACCT 803	<b>ACCOUNTING INFORMATION SYSTEMS</b> 3 cr. (3 and 0) Accounting systems including database concepts, systems design and evaluation, systems controls and systems implementation. <b>Prerequisites:</b> ACCT 302 and 303 or equivalent.
ACCT 804	<b>THE ENVIRONMENT OF ACCOUNTING</b> 3 cr. (3 and 0) Professional, legislative, judicial and social environments in which the accounting profession operates. <b>Prerequisite:</b> ACCT 415 or equivalent.
ACCT 806	<b>ADVANCED ACCOUNTING PROBLEMS</b> 3 cr. (3 and 0) Specialized aspects of financial accounting including business combinations accounting and reporting practices of regulated and non-regulated industries, emerging practices and developments in financial accounting, fund accounting, and corporate reorganizations and liquidations. <b>Prerequisite:</b> ACCT 302 or equivalent.
ACCT 807	<b>ADVANCED AUDITING TECHNIQUES</b> 3 cr. (3 and 0) Auditing and control techniques in an EDP environment, including statistical sampling techniques used by auditors and the auditor's use of microcomputers. <b>Prerequisite:</b> ACCT 415 or equivalent.
ACCT 814	<b>TAXATION OF BUSINESS ENTITIES</b> 3 cr. (3 and 0) The interrelationship of taxation and business decisions; designed for students not specializing in taxation.



- ing in taxation. **Prerequisite:** ACCT 404 or equivalent.
- ACCT 815** **FEDERAL AND STATE INCOME TAXATION OF CORPORATIONS**  
3 cr. (3 and 0)  
Tax principles and concepts involved in corporate-shareholder transactions, tax planning of corporations, Subchapter C and related provisions of the Internal Revenue Code. **Prerequisite:** ACCT 404 or equivalent.
- ACCT 816** **TAXATION OF ESTATES, GIFTS AND FIDUCIARIES**  
3 cr. (3 and 0)  
Federal estate and gift tax laws; federal income tax laws related to trusts and estates. **Prerequisite:** ACCT 404 or equivalent.
- ACCT 817** **TAX RESEARCH**  
3 cr. (3 and 0)  
Tax research methodology as applied to the solution of routine and complex tax problems, emphasizing the methodology of solution rather than a specific tax area. **Prerequisite:** ACCT 404 or equivalent.
- ACCT 818** **TAXATION OF PARTNERSHIPS**  
3 cr. (3 and 0)  
Tax principles and concepts involved in partnership transactions, tax planning and tax shelters. **Prerequisite:** ACCT 404 or equivalent.
- ACCT 819** **CURRENT AND SPECIAL TOPICS IN TAXATION**  
3 cr. (3 and 0)  
Specialized and contemporary topics in federal taxation and tax practice. **Prerequisite:** ACCT 404 or equivalent.
- ACCT 820** **ADVANCED TOPICS AND PLANNING IN TAXATION**  
3 cr. (3 and 0)  
Planning element for federal and state taxes in business decisions, including current, sophisticated developments in taxation. **Prerequisite:** ACCT 819 or permission of instructor.
- ACCT 821** **CONTROLLERSHIP**  
3 cr. (3 and 0)  
Advanced internal accounting emphasizing accounting implications for management decision making. **Prerequisite:** ACCT 303 or equivalent.
- ACCT 824** **ADVANCED MANAGERIAL ACCOUNTING**  
3 cr. (3 and 0)  
Current developments in cost and managerial accounting, emphasizing theories, applications, analysis and the behavioral impact of internal accounting data; completion of a field project required. **Prerequisite:** ACCT 410 or permission of instructor.
- ACCT 830** **GOVERNMENTAL AND NOT-FOR-PROFIT ACCOUNTING**  
3 cr. (3 and 0)  
Fund accounting and financial reporting for governments and other not-for-profit organizations; examines managerial control issues in the

not-for-profit environments. **Prerequisites:** ACCT 202 or 203 and permission of instructor.

- ACCT 840** **INTERNAL AUDITING SEMINAR**  
3 cr. (3 and 0)  
Advanced topics in internal auditing theory and practice, using case studies and readings. **Prerequisite:** ACCT 340 or 415 or equivalent.
- ACCT 845** **OPERATIONAL AUDITING SEMINAR**  
3 cr. (3 and 0)  
Management control and operational systems, opportunities for improvement and development of practical and cost effective solutions to managerial problems using selected readings from case studies and industry monographs provided by the Institute of Internal Auditing. **Prerequisite:** ACCT 340 or 415 or permission of instructor.
- LAW 605** **CONSTRUCTION LAW**  
3 cr. (3 and 0)
- LAW 629** **ENVIRONMENTAL LAW AND POLICY**  
3 cr. (3 and 0)
- LAW 699** **SELECTED TOPICS**  
1-3 cr. (1-3 and 0)

### *School of Business and Leadership*

#### **Applied Economics**

Daniel B. Smith, Chair, Department of Agricultural and Applied Economics

Major	Degree
Applied Economics	Ph.D.

See the College of Agriculture, Forestry and Life Sciences for information on this program.

#### **Business Administration**

Martha Duke, Associate Director\*

Major	Degree
Business Administration	M.B.A.

The Master of Business Administration degree program is designed for the study of advanced concepts of business, industry and government operations. The program is intended for both the active manager or technical supervisor, as well as the recent graduate interested in advanced business study.

Classes in the M.B.A. program are offered at the Clemson University campus as a full-time day program. Evening classes are offered on the campuses of Furman University in Greenville, S.C., and Lander University in Greenwood, S.C., as part-time programs. The Clemson campus program is available only for fall entrance and is a full-time, two-year program requiring all students to follow the same course sequence. The evening M.B.A. programs in Greenville and Greenwood are part-time programs and

\* Correspondence for the evening program on the Furman University campus should be addressed to Director, Clemson M.B.A. Program, Furman University, 119 Furman Hall, Greenville, S.C. 29613; or call (864) 294-2090. Correspondence for the daytime program on the Clemson campus as well as for classes at Lander University should be addressed to Director, Clemson M.B.A. Program, College of Business and Public Affairs, Clemson University, 124 Sirrine Hall, Clemson, S.C. 29634; or call (864) 656-3975. Information on the classes at Lander University can be obtained by calling (864) 229-8787.



require a minimum of two years of work experience beyond the bachelor's degree. In addition to the domestic programs, both full-time and executive degree programs are offered in Pordenone, Italy, in cooperation with the Consortium of Universities for International Business Studies. Separate fee structures apply to the Greenville and Greenwood locations, as well as to the location in Italy. (See page 19.)

Requirements for the full-time M.B.A. program include 60 semester hours of graduate credit, with two prerequisite courses required of all students: calculus and a basic computer science or computer applications class. The full-time program includes an option for taking classes during one summer in Italy. Requirements for the evening M.B.A. program include as many as 33 hours of prerequisite courses depending upon academic background, and 30 semester hours of graduate credit.

**M B A 802      MANAGERIAL ECONOMICS**

3 cr. (3 and 0)

Intensive study of the functioning of the market economy with emphasis on the role of prices in determining the allocation of resources, the functioning of the firm in the economy and forces governing the production of economic goods; emphasis is on using economic analysis in managerial decision making. **Prerequisites:** Economic principles and basic statistics.

**M B A 803      STATISTICAL ANALYSIS OF BUSINESS OPERATIONS**

3 cr. (3 and 0)

The role of statistical inference in the decision making of business managers; emphasis is on techniques and proper applications of modern statistical methods in business and on univariate and multivariate analysis, including analysis of variance, regression and covariance; sample theory and design, basic experimental designs and time series analysis. **Prerequisite:** Basic statistics.

**M B A 804      MANAGERIAL ACCOUNTING AND INFORMATION SYSTEMS**

3 cr. (3 and 0)

Preparation, analysis, interpretation and use of accounting information in the guidance and control of a business enterprise; case material and problems are used. **Prerequisites:** Principles of accounting and a demonstrated proficiency in basic finance.

**M B A 805      LEGAL AND SOCIAL ENVIRONMENT OF BUSINESS**

3 cr. (3 and 0) S

Interaction between business and the social, political and legal order; through analysis of particular situations, attention is focused on the broad effects of the total environment on the administration of business enterprise.

**M B A 806      OPERATIONS MANAGEMENT**

3 cr. (3 and 0)

Analytical methods as applied to business and industrial problems; basic mathematical and statistical models useful to management decision making in the functions of production, marketing, finance and general management are developed; emphasis is on the development and ap-

plication of deterministic and probabilistic models to problems in forecasting, production scheduling, inventory, maintenance, queuing, plant location, product lines, line balancing, critical path methods and simulation. **Prerequisites:** M B A 803 and a demonstrated proficiency in basic management.

**M B A 807  
(FIN 807)**

**FINANCIAL MANAGEMENT**

3 cr. (3 and 0)

Theory of financial management as it relates to the financial problems faced by business concerns; concepts developed are used to assess the validity of emerging formalized techniques for improving decision making in the financial area. Topics include financial planning, short- and long-term fund raising, capital budgeting, the administration of working capital, recapitalization, listing of securities and reorganization. Case material and problems are used. **Prerequisite:** Principles of accounting.

**M B A 808**

**MANAGERIAL PROBLEMS IN MARKETING**

3 cr. (3 and 0)

Major decisions facing marketing executives and top management in their attempt to harmonize the objectives and resources of the organization with the opportunities found in the marketplace; emphasizes recent theoretical developments in marketing and related disciplines and their application in management; readings, case analysis and discussions are used. **Prerequisite:** Principles of marketing.

**M B A 809  
(MGT 809)**

**ORGANIZATION THEORY AND BEHAVIOR**

3 cr. (3 and 0)

Advanced consideration of theories and models as they apply to managing individual and work-group behavior in organizations. Topics include leadership, decision making, motivation, power, conflict, communication, job design and group processes. **Prerequisite:** Graduate standing.

**M B A 810**

**MANAGERIAL POLICY**

3 cr. (3 and 0)

Decisions involved in the establishment of managerial policy; problems, resources and alternative courses of action are analyzed and discussed relative to the selection of company objectives and the most feasible means for achieving company goals; integrates material and treats the coordination of the affairs of the firm as a whole; case studies are emphasized. This course should be completed as the final course in the program.

**M B A 811**

**INTERNATIONAL BUSINESS MANAGEMENT**

3 cr. (3 and 0) N

Survey and analysis of economic, managerial and financial aspects of U.S. firms operating abroad, including the impact of U.S. and foreign government policies on management; case studies of specific companies operating abroad are discussed. **Prerequisites:** M B A 802 and 807 or equivalent.



- M B A 812 (FIN 812)** **FINANCIAL MARKETS AND INSTITUTIONS**  
3 cr. (3 and 0) N  
Topics critical to the proper management of financial institutions, including financial regulations, financial security types and their yields, interest rate theories, interest rate risk management, foreign currency risk management, stock index futures and numerous operating functions in banking. **Prerequisite:** M B A/FIN 807 or M B A 857 or permission of instructor.
- M B A 813** **INDUSTRIAL RELATIONS**  
3 cr. (3 and 0) N  
Relationship between management and employees, as institutions and as individuals; the role of management and unions in society; issues in labor-management relations. Topics include the issues and processes of collective bargaining, contract negotiation and administration, and dispute resolution; government regulation of labor relations is also examined.
- M B A 814** **DIRECTED RESEARCH IN QUANTITATIVE ANALYSIS**  
3 cr. (3 and 0) N
- M B A 815** **DIRECTED RESEARCH IN QUALITATIVE ANALYSIS**  
3 cr. (3 and 0) N
- M B A 816** **CONTRACTS, CORPORATE COORDINATION AND CONTROL**  
3 cr. (3 and 0) N  
Evolution and impact of various property rights institutions on individual behavior and the subsequent use of resources; particular attention is paid to the importance of property rights structures in the organization of business and in managerial decision making. **Prerequisite:** M B A 802 or equivalent.
- M B A 817** **BUSINESS FORECASTING TECHNIQUES AND APPLICATIONS**  
3 cr. (3 and 0) N  
Forecasting techniques and their application for developing and assessing forecasts. Topics include economic data sources, multiple regression and time series analysis, and the interpretation of forecasts for management and other clients. **Prerequisite:** M B A 802, 803 or equivalent.
- M B A 820** **BUSINESS COMMUNICATIONS AND ETHICS**  
3 cr. (3 and 0) F  
A case-based study of varied ethical and moral dilemmas encountered in the business environment, emphasizing the student's written work; development and communication of a reasoned personal framework for the resolution of ethical issues through frequent written assignments. **Prerequisite:** Graduate standing.
- M B A 822** **CORPORATE FINANCIAL REPORTING**  
3 cr. (3 and 0) N  
Current state of financial reporting practices and requirements, the ways financial statements and data affect the economic system, and the significance of these practices to users of financial statements.
- M B A 823** **INTERNATIONAL ACCOUNTING**  
3 cr. (3 and 0) N  
Technical and nontechnical issues in international accounting. Topics include the role of international bodies in developing standards, accounting issues dealing with exports and imports, and the role of accounting and MNCs in development.
- M B A 824** **THE MANAGEMENT OF SALES OPERATIONS**  
3 cr. (3 and 0) N  
The sales function as an element of marketing strategy; the field of professional sales management; concepts and tools useful to managers at different levels of the sales organization. **Prerequisite:** M B A 808 or 858 or permission of instructor.
- M B A 825** **ADVERTISING AND PROMOTIONAL MANAGEMENT**  
3 cr. (3 and 0) N  
The role of promotion in the marketing mix, emphasizing the types of decisions and decision areas affiliated with promotional planning; students are exposed to and apply topics such as objective setting, budgeting, media planning and scheduling, and societal/economic impact of promotion. **Prerequisite:** M B A 808 or 858 or permission of instructor.
- M B A 826** **BUSINESS MARKETING**  
3 cr. (3 and 0) N  
Strategic marketing as it applies to industrial, organizational and institutional markets; consumer marketing versus business-to-business marketing; current business marketing literature and practices. **Prerequisite:** M B A 808 or 858 or permission of instructor.
- M B A 828** **SERVICES MARKETING**  
3 cr. (3 and 0) N  
The nature of services marketing and the special requisites that distinguish successful services marketing from goods marketing. Topics include promoting and making the service tangible, designing optimal service operations, the ideal service worker, pricing of services and critical points of services delivery. **Prerequisite:** M B A 808 or 858 or permission of instructor.
- M B A 832 (FIN 832)** **INTERNATIONAL FINANCIAL MANAGEMENT**  
3 cr. (3 and 0) N  
Factors that influence the financial management of multinational corporations. Topics include international parity conditions, currency exposure management, capital budgeting of international projects and political risks. **Prerequisite:** M B A/FIN 807 or M B A 857 or permission of instructor.



- M B A 835 (FIN 835) INVESTMENT MANAGEMENT**  
3 cr. (3 and 0) N  
Current techniques and strategies in the analysis of various investment alternatives; portfolio management with an introduction to options and futures markets. **Prerequisites:** Principles of accounting and a demonstrated proficiency in basic finance.
- M B A 836 (FIN 836) REAL ESTATE FINANCE AND INVESTMENTS**  
3 cr. (3 and 0) N  
Practices and analysis of real estate finance and investment. Topics include real estate financing techniques, mortgage loan underwriting, real estate ownership structure and syndications, real estate taxation and real estate investment risk analysis. **Prerequisite:** M B A/FIN 807 or M B A 857 or permission of instructor.
- M B A 840 WORLD INDUSTRIAL POLICY**  
3 cr. (3 and 0) SS  
Theory and institutions that form the basis for worldwide national industrial policies; examination of the basis for and effect of policies affecting mergers, consolidations, export assistance, coordination of industries and other government actions taken that affect the legal and economic environment for transnational business. **Prerequisite:** M B A 802.
- M B A 845 TECHNOLOGY AND INNOVATION MANAGEMENT**  
3 cr. (3 and 0)  
Interdisciplinary examination of problems and issues in integrating technology and innovation into processes and products; evaluating tangible and intangible aspects of new technology adoption; management research and development; and functional integration of marketing and operations.
- M B A 851 FINANCIAL ACCOUNTING**  
3 cr. (3 and 0) F  
Accounting as a system which provides financial information for economic decision making; accounting from the perspective of the user in debt/equity financing activities and decisions, investing activities and decisions, and operating activities and decisions; measuring, processing and reporting financial information as a basis for better user understanding. **Prerequisite:** Permission of the M.B.A. director.
- M B A 852 FOUNDATIONS OF ECONOMICS**  
3 cr. (3 and 0) F  
Key concepts and theories in economics and how a market economy operates, concentrating on microeconomics, but also covering key macroeconomic topics. Topics include market systems, pricing mechanisms, monetary systems, inflation, employment, interest rates, consumer behavior and regulation. **Prerequisite:** Permission of the M.B.A. director.
- M B A 853 STATISTICAL ANALYSIS FOR BUSINESS**  
3 cr. (3 and 0) F  
Application of modern statistical inference in business operations. Topics include testing statistical hypotheses, consequences of making decisions with incomplete information, univariate and multivariate regression with emphasis on business applications, and design of experiments and analysis of variance with special attention given to efficient and relevant data collection and interpretation. **Prerequisite:** Permission of the M.B.A. director.
- M B A 854 MANAGERIAL ACCOUNTING**  
3 cr. (3 and 0) S  
Preparation, analysis and interpretation of internal accounting information used to guide and control the business organizations as well as nonbusiness enterprise; case materials and problems are used. **Prerequisite:** M B A 851 or permission of instructor.
- M B A 856 OPERATIONS MANAGEMENT**  
3 cr. (3 and 0) S  
Strategic and tactical issues involved in the design, planning and control of the operating system in service and manufacturing organizations. Topics include operations strategy, process choice, facility design, planning and scheduling, and methods for continuous improvement. **Prerequisites:** M B A 853 and 859 or permission of instructor.
- M B A 857 MANAGERIAL FINANCE**  
3 cr. (3 and 0) S  
Theory of financial management as it relates to financial problems faced by business concerns; concepts developed are used to assess the validity of emerging formalized techniques for improving decision making in the financial area; case analysis is used to bridge the gap between theory and practice. **Prerequisites:** M B A 851 and 852 or permission of instructor.
- M B A 858 MANAGERIAL MARKETING**  
3 cr. (3 and 0) S  
Key marketing concepts and theories with extensive application to a broad range of business and not-for-profit situations; analysis of marketing opportunities and threats, researching and selecting target markets, and developing and comparing marketing strategies to prepare students to develop advanced marketing strategies. **Prerequisite:** M B A 853 or permission of instructor.
- M B A 859 MANAGEMENT SCIENCE APPLICATIONS**  
3 cr. (3 and 0) F  
Management science techniques and their application to a wide range of managerial decisions. Topics include queuing models, linear programming, transportation problems and simulation. **Prerequisite:** Permission of the M.B.A. director.
- M B A 860 ADVANCED MARKETING STRATEGY**  
3 cr. (3 and 0) F  
Advanced marketing theory and critical thinking skills applied to support strategic decision making; comprehensive case studies and advanced marketing models generally utilized with emphasis on building analysis and professional presentation skills. **Prerequisite:** M B A 858 or permission of instructor.



- M B A 861 (MGT 861)** **MANAGEMENT INFORMATION SYSTEMS DEVELOPMENT**  
3 cr. (3 and 0) SS  
See MGT 861 for description.
- M B A 862** **MANAGERIAL ECONOMICS**  
3 cr. (3 and 0) S  
Use of economic analysis in managerial decision making. Topics include the theory of cost, production, industrial organization, coordination and control of the firm, property rights, and the economics of information, emphasizing the application of theoretical concepts to actual decision making. **Prerequisite:** M B A 852 or permission of instructor.
- M B A 867 (FIN 867)** **ADVANCED FINANCIAL MANAGEMENT**  
3 cr. (3 and 0)  
Students develop financial problem-solving skills through case analysis, class discussion, reading assignments and a project. **Prerequisite:** M B A/FIN 807 or M B A 857 or permission of instructor.
- M B A 870** **STRATEGIC MANAGEMENT**  
3 cr. (3 and 0) S, SS  
On-going process of positioning a firm for competitive advantage in its changing business environment, focusing on the role of general managers in formulating and implementing strategies for single and multibusiness firms; business cases, class discussions and group projects used to integrate content from previous business courses. **Prerequisites:** M B A 805, 809, 820, 859, 860, 861 and 867 or permission of instructor.
- M B A 874 (MGT 874)** **MANAGING CONTINUOUS IMPROVEMENT**  
3 cr. (3 and 0)  
See MGT 874 for description.
- MBA 875** **ENTERPRISE DEVELOPMENT**  
3 cr. (3 and 0)  
Entrepreneurial process from conception to birth of new venture; emphasizing discovery, searching for opportunities and gathering resources to convert opportunities to businesses. Students learn how to evaluate entrepreneurs and their plans by working in teams to write a business plan for a new venture.
- M B A 888** **INTERNSHIP IN BUSINESS ADMINISTRATION**  
3 cr. (3 and 0)  
Preplanned, preapproved, faculty-supervised internships designed to give students on-the-job learning in support of classroom education; credit is not given for internships less than six full-time consecutive weeks with the same internship provider. May be repeated for a maximum of six credits. Does not count toward required graduation hours. Graded on a pass/fail basis. **Prerequisites:** Twenty-four semester hours of graduate credit and permission of the M.B.A. director.

- M B A 889** **ORGANIZATION DESIGN AND THEORY**  
3 cr. (3 and 0) N  
Topics include structuring of organizations, external environment, goals and effectiveness, organizational change, power and politics, organization culture and other topics focusing on the total organization, as opposed to individual behavior in organizations.
- M B A 890** **TOPICS IN STRATEGIC MANAGEMENT**  
3 cr. (3 and 0) N  
Issues facing today's executive; current relevant literature examined and discussed in a graduate seminar environment. Topics may vary with each offering.
- M B A 895** **TOPICS IN MARKETING**  
3 cr. (3 and 0) N  
In-depth study of a current topic in marketing. **Prerequisite:** M B A 808.

### Economics

William R. Dougan, Chair, Department of Economics

Majors	Degrees
Economics	M.A.
Applied Economics	Ph.D.

Applicants to the M.A. degree program must have completed at least 12 semester hours of undergraduate economics, including a course in intermediate price theory. A background in mathematics, including at least one course each in calculus and statistics, also is required. When necessary, the economic theory, mathematics and statistics courses may be taken at Clemson University.

The graduate program will include at least one course in econometrics and a minimum of two courses in economic theory. Program concentrations in financial economics, labor economics, monetary economics, environmental economics, industrial organization and public sector economics have been designed for students interested in these areas.

Both thesis and nonthesis options are available. The thesis option requires completion of 24 semester hours of course work and submission of an approved thesis. The nonthesis option requires completion of 30 semester hours of course work and a passing score on the M.A. qualifying examination. With the consent of the graduate coordinator, a maximum of six hours of course work credit may be earned for graduate courses taken outside the Department of Economics. All remaining courses must be selected from within the department.

Applicants to the Ph.D. program should have a strong background in economic theory and statistics. The program has required fields in these areas. Students choose two additional fields of concentration from those listed above and others supported by departments across the University.

- ECON 603** **DEVELOPMENT OF ECONOMIC THOUGHT**  
3 cr. (3 and 0)
- ECON 604** **COMPARATIVE ECONOMIC SYSTEMS**  
3 cr. (3 and 0)
- ECON 605** **INTRODUCTION TO ECONOMETRICS**  
3 cr. (3 and 0)
- ECON 610** **ECONOMIC DEVELOPMENT**  
3 cr. (3 and 0)
- ECON 612** **INTERNATIONAL MICROECONOMICS**  
3 cr. (3 and 0) S



<b>ECON 619</b>	<b>ECONOMICS OF DEFENSE</b> 3 cr. (3 and 0)		
<b>ECON 620</b>	<b>PUBLIC SECTOR ECONOMICS</b> 3 cr. (3 and 0)	<b>ECON 808</b> (MA SC 808) (AP EC 808)	<b>ECONOMETRICS III</b> 3 cr. (3 and 0) S Continuation of ECON 807; current economic models and estimation procedures. <b>Prerequisite:</b> ECON 807.
<b>ECON 622</b>	<b>MONETARY THEORY AND POLICY</b> 3 cr. (3 and 0)	<b>ECON 809</b> (AP EC 809)	<b>ADVANCED NATURAL RESOURCE ECONOMICS</b> 3 cr. (3 and 0) S See AP EC 809 for description.
<b>ECON 624</b>	<b>THE ORGANIZATION OF INDUSTRIES</b> 3 cr. (3 and 0) F	<b>ECON 810</b> (AP EC 810)	<b>NATURAL RESOURCES MANAGEMENT AND POLICY</b> 3 cr. (3 and 0) F See AP EC 810 for description.
<b>ECON 750</b>	<b>ECONOMIC CONCEPTS AND CLASSROOM APPLICATIONS FOR TEACHERS</b> 3 cr. (3 and 0) Economic concepts, analysis and methods emphasizing microeconomics and the market system; development of approaches to teaching economic concepts in public schools.	<b>ECON 811</b> (AP EC 811)	<b>ECONOMICS OF ENVIRONMENTAL QUALITY</b> 3 cr. (3 and 0) F (even numbered years) Pricing and distribution emphasizing effects upon economic welfare; goods allocated by government purchase for joint consumption and those distributed by rationing; alternate plans for allocating public goods. <b>Prerequisite:</b> ECON 314 or equivalent.
<b>ECON 751</b>	<b>SELECTED TOPICS FOR TEACHERS</b> 3 cr. (3 and 0) Current economic policy issues, such as inflation, regulation, protectionism and energy policy, emphasizing the presentation of these topics to secondary school students. Topics vary from year to year. May be taken more than once for credit. <b>Prerequisite:</b> ECON 200, 211 or 750.	<b>ECON 816</b> (AP EC 816)	<b>LABOR ECONOMICS</b> 3 cr. (3 and 0) Wage and employment theory; labor markets; labor history; current problems in labor and manpower economics.
<b>ECON 800</b> (AP EC 800)	<b>HISTORY OF ECONOMIC THOUGHT</b> 3 cr. (3 and 0) Development of economic thought from early Greek to Keynesian economics; writings of major economists such as Smith, Ricardo, Marx, Marshall and Keynes; development of major economic theories.	<b>ECON 817</b> (AP EC 817)	<b>ADVANCED PRODUCTION ECONOMICS</b> 3 cr. (3 and 0) S See AP EC 817 for description.
<b>ECON 801</b> (AP EC 801)	<b>MICROECONOMIC THEORY</b> 3 cr. (3 and 0) Microeconomic theory and its use to analyze and predict the behavior of industries, firms and consumers under various market conditions.	<b>ECON 820</b> (AP EC 820)	<b>PUBLIC FINANCE</b> 3 cr. (3 and 0) Impact of government on resource allocation, income distribution and stability; role of regulation; principles of taxation.
<b>ECON 802</b> (AP EC 802)	<b>ADVANCED ECONOMIC CONCEPTS AND APPLICATIONS</b> 3 cr. (3 and 0) Rigorous development of price theory under alternative product and resource market structures. <b>Prerequisite:</b> Permission of instructor.	<b>ECON 821</b> (AP EC 821)	<b>PUBLIC CHOICE</b> 3 cr. (3 and 0) Economic theory to analyze collective decisions. Topics include the pure theory of collective choice and applied analyses of democratic governments and their policy processes.
<b>ECON 804</b> (AP EC 804)	<b>APPLIED MATHEMATICAL ECONOMICS</b> 3 cr. (3 and 0) See AP EC 804 for description.	<b>ECON 822</b> (AP EC 822)	<b>CONTEMPORARY PUBLIC POLICY</b> 3 cr. (3 and 0) S See AP EC 822 for description.
<b>ECON 805</b>	<b>MACROECONOMIC THEORY</b> 3 cr. (3 and 0) S Macroeconomic theory involving static and dynamic models and their use in analysis of economic problems and policies.	<b>ECON 824</b> (AP EC 824)	<b>ORGANIZATION OF INDUSTRY</b> 3 cr. (3 and 0) The structure of markets and firms; forces that determine the size of firms and the boundaries of markets; emphasis on the behavior of firms, both singly and in concert, to exploit market positions.
<b>ECON 806</b> (AP EC 806)	<b>ECONOMETRICS I</b> 3 cr. (3 and 0) See AP EC 806 for description.	<b>ECON 826</b> (AP EC 826)	<b>ECONOMIC THEORY OF GOVERNMENT REGULATION</b> 3 cr. (3 and 0) The scope of governmental regulation in the economy of the United States, its evolution and development; emphasis on the application
<b>ECON 807</b> (MA SC 807) (AP EC 807)	<b>ECONOMETRICS II</b> 3 cr. (3 and 0) F Economic models expressed as systems of equations; problems of identification, parameter estimation, measurement errors and statis-		tical inference; techniques of simulation, forecasting, model validation and interpretation.



	of the tools of economic analysis to the issues of regulated enterprise. <b>Prerequisite:</b> ECON 314 or equivalent.		
<b>ECON 827</b> (AP EC 827)	<b>ECONOMICS OF PROPERTY RIGHTS</b> 3 cr. (3 and 0) Evolution and impact of various property rights institutions on individual behavior and the subsequent use of resources; particular attention given to the importance of property rights structures in the organization of business and in managerial decision making. <b>Prerequisite:</b> ECON 801.	<b>ECON 891</b>	<b>MASTER'S THESIS RESEARCH</b> Credit to be arranged.
<b>ECON 828</b> (AP EC 828)	<b>MARKET STRUCTURE IN AGRICULTURAL INDUSTRIES</b> 3 cr. (3 and 0) See AP EC 828 for description.	<b>ECON 899</b> (AP EC 899)	<b>SELECTED TOPICS</b> 1-3 cr. (1-3 and 0) F, S See AP EC 899 for description.
<b>ECON 831</b> (AP EC 831)	<b>ECONOMIC DEVELOPMENT</b> 3 cr. (3 and 0) Economic analysis of development of urban areas within the system of cities; central place theory and general equilibrium models of interregional economic activity emphasizing central place systems, spatial interaction and stochastic processes; internal development of the city focusing on housing and land use patterns, transportation and urban form.	<b>ECON 900</b>	<b>SELECTED TOPICS IN ECONOMICS</b> 3 cr. (3 and 0) F (odd numbered years) Current topics in economic theory and empirical research. May be taken more than once for credit as long as subject matter is not repetitive.
<b>ECON 832</b> (AP EC 832)	<b>COMMUNITY AND REGIONAL ECONOMICS</b> 3 cr. (3 and 0) See AP EC 832 for description.	<b>ECON 901</b> (AP EC 901)	<b>PRICE THEORY</b> 3 cr. (3 and 0) Neoclassical paradigm of market price and quantity; rigorous consideration of consumer behavior, the theory of the firm and market equilibrium, production and resource demands, and the supply of resources. <b>Prerequisite:</b> ECON 801 or equivalent.
<b>ECON 840</b> (AP EC 840)	<b>INTERNATIONAL TRADE THEORY</b> 3 cr. (3 and 0) Theory of free trade from Ricardo to present; theory and application of optimal and second-best tariffs; recent empirical testing of trade and tariff theory. <b>Prerequisites:</b> ECON 314 and 802 or permission of instructor.	<b>ECON 903</b> (AP EC 903)	<b>GENERAL EQUILIBRIUM AND WELFARE THEORY</b> 3 cr. (3 and 0) S See AP EC 903 for description.
<b>ECON 841</b> (AP EC 841)	<b>INTERNATIONAL FINANCE</b> 3 cr. (3 and 0) Financial economics of decision making in a multinational environment featuring autonomous governments and multiple currencies. Typical topics include examination of the macroeconomic problems of unemployment and inflation in an international economy, management of exchange rate risk, credit risk, political risk and taxation. <b>Prerequisite:</b> ECON 315 or equivalent.	<b>ECON 904</b> (AP EC 904)	<b>SEMINAR IN RESOURCE ECONOMICS</b> 3 cr. (3 and 0) F See AP EC 904 for description.
<b>ECON 855</b> (AP EC 855)	<b>FINANCIAL ECONOMICS</b> 3 cr. (3 and 0) Modern theory of corporate finance; basic theories of efficient markets, portfolio selection, capital asset pricing, option pricing and agency costs. <b>Prerequisite:</b> ECON 801 or permission of instructor.	<b>ECON 905</b> (AP EC 905)	<b>ADVANCED MACROECONOMIC ISSUES</b> 3 cr. (3 and 0) Current unsettled issues in macroeconomic analysis. Topics include disequilibrium macro models, macro models of open economies, rational expectations and its critics, government stabilization policies and the controversy surrounding the concept of Ricardian equivalence. <b>Prerequisite:</b> ECON 805 or equivalent.
<b>ECON 888</b> (AP EC 888)	<b>DIRECTED READING IN ECONOMICS</b> 1-3 cr. (1-3 and 0) Directed reading and research in the student's field of interest. May be repeated for up to three credit hours.	<b>ECON 906</b> (AP EC 906)	<b>SEMINAR IN AREA ECONOMIC DEVELOPMENT</b> 3 cr. (3 and 0) S See AP EC 906 for description.
		<b>ECON 911</b>	<b>PROBLEMS IN PRICE THEORY</b> 3 cr. (3 and 0) Price theory problems and exercises in preparation for standing the comprehensive examination preliminary to admission to candidacy to the Ph.D. degree in applied economics. May be repeated up to three times.
		<b>ECON 917</b> (AP EC 917)	<b>ADVANCED SEMINAR IN LABOR ECONOMICS</b> 3 cr. (3 and 0) Follow-up to ECON 816, bridging the gap between theory and modern empirical research in labor economics; emphasis on reading recent empirical research papers to understand the techniques of modern research in labor economics. <b>Prerequisite:</b> ECON 816.
		<b>ECON 950</b> (AP EC 950)	<b>MONETARY ECONOMICS</b> 3 cr. (3 and 0) Economic analysis of money in our economy and effects of monetary policy on prices, interest rates, output and employment.



**ECON 991 DOCTORAL DISSERTATION RESEARCH**  
(AP EC 991) Credit to be arranged.

## Finance

Robert B. McElreath, Chair, Department of Finance

Advanced degrees are not awarded in finance. Courses are offered to meet requirements and provide electives for students in other areas.

**FIN 605 PORTFOLIO MANAGEMENT AND THEORY**  
3 cr. (3 and 0)

**FIN 606 STOCK OPTIONS AND FUTURES MARKETS**  
3 cr. (3 and 0)

**FIN 610 RESEARCH IN FINANCE**  
1-3 cr. (1-3 and 0)

**FIN 615 REAL ESTATE INVESTMENT**  
3 cr. (3 and 0)

**FIN 617 REAL ESTATE FINANCE**  
3 cr. (3 and 0)

**FIN 807 FINANCIAL MANAGEMENT**  
(M B A 807) 3 cr. (3 and 0)  
See M B A 807 for description.

**FIN 812 FINANCIAL MARKETS AND INSTITUTIONS**  
(M B A 812) 3 cr. (3 and 0) N  
See M B A 812 for description.

**FIN 832 INTERNATIONAL FINANCIAL MANAGEMENT**  
(M B A 832) 3 cr. (3 and 0) N  
See M B A 832 for description.

**FIN 835 INVESTMENT MANAGEMENT**  
(M B A 835) 3 cr. (3 and 0) N  
See M B A 835 for description.

**FIN 836 REAL ESTATE FINANCE AND INVESTMENTS**  
(M B A 836) 3 cr. (3 and 0) N  
See M B A 836 for description.

**FIN 867 ADVANCED FINANCIAL MANAGEMENT**  
(M B A 867) 3 cr. (3 and 0)  
See M B A 867 for description.

## Graphic Communications

William E. West, Chair, Department of Graphic Communications

Advanced degrees are not awarded in graphic communications. Courses are offered to meet requirements and provide electives for students in other areas.

**G C 606 PROBLEMS IN SPECIALTY PRINTING**  
4 cr. (2 and 6)

**G C 607 ADVANCED FLEXOGRAPHIC METHODS**  
4 cr. (2 and 6)

**G C 610 SELECTED TOPICS**  
(TH R D 610) 1-3 cr. (1-3 and 0)

**G C 640 ADVANCED LITHOGRAPHIC METHODS**  
5 cr. (2 and 9)

**G C 644 CURRENT DEVELOPMENTS AND TRENDS IN GRAPHIC COMMUNICATIONS**  
4 cr. (2 and 6)

**G C 645 ADVANCED SCREEN PRINTING METHODS**  
3 cr. (2 and 3)

**G C 646 INK AND SUBSTRATES**  
3 cr. (2 and 3)

**G C 648 PLANNING AND CONTROLLING PRINTING FUNCTIONS**  
3 cr. (3 and 0)

**G C 801 PROCESS CONTROL IN COLOR REPRODUCTION**  
3 cr. (2 and 3)  
Emphasis on techniques and rationale for procedures used in reproducing color originals for printed media. Topics include color systems, measurement, reproduction characteristics, proofing systems, process evaluation/analysis for offset, flexographic, gravure and screen printing processes. **Prerequisite:** G C 444 or equivalent.

**G C 895 SPECIAL PROBLEMS I**  
(IN ED 895) 3 cr. (3 and 0)  
See IN ED 895 for description.

**G C 896 SPECIAL PROBLEMS II**  
(IN ED 896) 3 cr. (3 and 0)  
See IN ED 896 for description.

## Industrial Management

David W. Grisby, Chair, Department of Management

<b>Major</b>	<b>Degrees</b>
Industrial Management	M.S., Ph.D.

The M.S. program in industrial management is designed to prepare graduates for leadership positions in industry by focusing on the management of operations. The program also prepares students for further advanced study in the field of management.

Requirements for the M.S. degree include a minimum of 48 semester hours of graduate work beyond the bachelor's degree. All students take 12 hours of foundation course work addressing topics in finance, accounting, marketing and economics, as well as 27 hours of core courses involving strategic, behavioral and technical issues in operations management. Nine semester hours are earned through a field project that extends over several academic terms. Admissions occur only in the fall semester, and all students must follow the same course sequence requiring full-time enrollment, including summer sessions, through the end of the fall semester of the subsequent year.

The Ph.D. program is designed to develop a high-level management scholar capable of applying the most advanced concepts and methods of analysis and research to industrial management problems. It also provides excellent preparation for a university teaching and research career.

The Ph.D. program is a balanced program of management theory, analytical technique and research methodology. Each student is expected to show competency in three areas of study: management, production/operations analysis and statistical analysis/research methodology. Each student also must complete a minimum of 12 semester credit hours in a specified area of con-



centration. Choice of an area of concentration and selection of courses within the area are made in consultation with the student's advisory committee.

- MGT 602 OPERATIONS PLANNING AND CONTROL**  
3 cr. (3 and 0)
- MGT 606 LOCATION ECONOMICS**  
3 cr. (3 and 0)
- MGT 608 DESIGN OF OPERATIONS SYSTEMS**  
3 cr. (3 and 0)
- MGT 615 BUSINESS STRATEGY**  
3 cr. (3 and 0)
- MGT 616 MANAGEMENT OF HUMAN RESOURCES**  
3 cr. (3 and 0)
- MGT 618 MANAGEMENT INFORMATION SYSTEMS**  
3 cr. (3 and 0)
- MGT 623 INTERNATIONAL BUSINESS MANAGEMENT**  
3 cr. (3 and 0)
- MGT 624 INTERNATIONAL TRANSPORTATION AND LOGISTICS**  
3 cr. (3 and 0)
- MGT 625 COMPENSATION MANAGEMENT**  
3 cr. (3 and 0)
- MGT 801 PRODUCTION AND PRICING ANALYSIS**  
3 cr. (3 and 0)  
Mathematical formulation of production and pricing theory as it applies to management decision making; analytical techniques of production and pricing analysis. **Prerequisite:** MGT 409/609 or permission of instructor.
- MGT 803 OPERATIONS MANAGEMENT**  
3 cr. (3 and 0) F  
Introduction to a broad range of operations management topics; foundation for understanding the importance, relevance and significance of analytical models and tools to be introduced in subsequent courses in the MSIM program. Topics include operations strategy, process and facility design, planning and control, quality management and continuous improvement. **Prerequisite:** Graduate standing.
- MGT 804 MANAGERIAL POLICY**  
3 cr. (3 and 0) F  
Management policy making, emphasizing determining objectives and developing sound policies for achieving them; builds upon and integrates the other graduate courses; case method is used extensively; written and oral presentation required. **Prerequisite:** MGT 803, M B A/ FIN 807 or permission of instructor.
- MGT 805 ADVANCED QUALITY CONTROL**  
3 cr. (3 and 0) F  
Statistical techniques employed in complex quality control schemes including recent developments in statistical quality control. **Prerequisite:** Permission of instructor.

- MGT 807 COMPARATIVE MANAGEMENT THEORY**  
3 cr. (3 and 0)  
Evolution of management theory, up to and including contemporary theories; comprehensive review of the major schools of management thought, with emphasis on the area of organization theory and design. **Prerequisite:** Graduate standing.
- MGT 808 MANUFACTURING PLANNING AND CONTROL SYSTEMS**  
3 cr. (3 and 0) F  
Important components of a manufacturing planning and control system, emphasizing the integration of planning and control functions in a dynamic manufacturing environment; extensive hands-on work with integrated manufacturing software. **Prerequisite:** MGT 803 or permission of instructor.
- MGT 809 (M B A 809) ORGANIZATION THEORY AND BEHAVIOR**  
3 cr. (3 and 0) F  
Advanced consideration of theories and models as they apply to managing individual and work-group behavior in organizations. Topics include leadership, decision making, motivation, power, conflict, communication, job design and group processes. **Prerequisite:** Graduate standing.
- MGT 812 BUSINESS LOGISTICS MANAGEMENT**  
3 cr. (3 and 0) SS  
In-depth examination of business activities related to transportation, inventory management, order processing and warehousing of raw materials and finished goods. Topics also include interfaces with production/operations and marketing. **Prerequisite:** MGT 305 or 317 or permission of instructor.
- MGT 813 BUSINESS RESEARCH**  
3 cr. (3 and 0)  
Business research to support management decision making. Topics include information collection and analysis and report preparation and presentation; requires the use of integrated microcomputer software for the preparation of student reports. **Prerequisites:** MA SC 814 and MGT 399 or equivalent.
- MGT 815 PERSONNEL MANAGEMENT**  
3 cr. (3 and 0)  
Personnel management activities, including recruitment, selection, training and development, performance appraisal, discipline, grievance handling, wage and salary administration, and employee benefit programs. **Prerequisite:** Graduate standing.
- MGT 818 MANAGEMENT SUPPORT SYSTEMS**  
3 cr. (3 and 0)  
Computer-based management support systems.



- MGT 820 SERVICE OPERATIONS MANAGEMENT**  
3 cr. (3 and 0)  
Concepts and techniques of service operating system design and management. Topics include characteristics of services, service system performance measurement, queuing and automation, planning and control in different service environments, and international service operations. **Prerequisite:** MGT 803 or permission of instructor.
- MGT 821 PROCESS AND FACILITY DESIGN**  
3 cr. (3 and 0)  
Design of operating systems, emphasizing the implications of technology and automation. Topics include technological core competencies, technological forecasting, process design, capacity planning, facility location and layout, and product and process development processes. **Prerequisite:** MGT 803 or permission of instructor.
- MGT 822 INTERNATIONAL OPERATIONS MANAGEMENT**  
3 cr. (3 and 0)  
Operations management within an international business environment. Topics include the regulatory and cultural environment of international business, international business and operations strategies, global location, global sourcing and logistics decisions, international workforce management, technology transfer and configuration, and coordination of global operations activities. **Prerequisite:** MGT 803 or permission of instructor.
- MGT 861 (M B A 861) MANAGEMENT INFORMATION SYSTEMS DEVELOPMENT**  
3 cr. (3 and 0) SS  
Overview of information technologies used by organizations for supporting operations and gaining competitive advantage; concepts and methods for modeling, analysis and design of information systems which support a business. Topics include systems analysis, object-oriented modeling and database design. **Prerequisite:** Basic computer skills as specified in prerequisites for the master's degree program.
- MGT 874 (MBA 874) MANAGING CONTINUOUS IMPROVEMENT**  
3 cr. (3 and 0)  
How to initiate and lead change toward a total quality environment; basic tools of quality management; use of teams to achieve change; quality function deployment; ISO 9000; supplier development; and use of survey methods to track progress of change. **Prerequisite:** MGT 803 or permission of instructor.
- MGT 888 INTERNATIONAL PERSPECTIVES IN INDUSTRIAL MANAGEMENT**  
3-6 cr. (3-6 and 0)  
International perspective to industrial management via organized plant visitations to businesses in a foreign country and lectures by, and discussions with, senior operations manager(s); cultural visits and lectures are also organized to provide a holistic perspective to cover cultural and economic development of the host country. **Prerequisite:** Permission of instructor.
- MGT 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- MGT 892 MASTER'S PROJECT COURSE**  
3 cr. (0 and 9)  
The field project, the capstone activity in the program, requires application of the program body of knowledge to a real-world operations management problem; a formal presentation and written report are required. May be repeated for a maximum of 12 credit hours. **Prerequisite:** Permission of instructor.
- MGT 903 SEMINAR IN MANUFACTURING PLANNING AND CONTROL SYSTEMS**  
3 cr. (3 and 0)  
Current research issues and developments in manufacturing planning and control systems, emphasizing current research (philosophical, analytical and empirical) dealing with alternative approaches for planning and control of manufacturing operations. **Prerequisite:** MGT 803 or permission of instructor.
- MGT 904 SEMINAR IN CURRENT MANAGEMENT TOPICS**  
3 cr. (3 and 0)  
Topics from current management literature; emphasis is on research from scholarly journals. Topics vary in keeping with developments in the literature. May be repeated with different faculty for a maximum of six credit hours. **Prerequisite:** Permission of instructor.
- MGT 905 RESEARCH METHODS**  
3 cr. (3 and 0)  
Research methods supporting scholarly research and publication in management. Topics include theory building, hypothesis specification and testing, experimental design, measurement, sampling, research ethics and related issues. Enrollment restricted to doctoral students. **Prerequisite:** MA SC 814 or equivalent.
- MGT 910 SEMINAR IN OPERATIONS MANAGEMENT**  
1-3 cr. (1-3 and 0)  
New methodological developments, both analytical and philosophical, in operations management; development of theory of management science; converting management theory into practice while considering behavioral and economic aspects of the problem. **Prerequisite:** Permission of instructor.
- MGT 911 SEMINAR IN DECISION THEORY**  
1-3 cr. (1-3 and 0)  
Framework and methodology for management decision making in a statistical setting. **Prerequisite:** Permission of instructor.
- MGT 913 MANAGEMENT SYSTEMS ANALYSIS**  
3 cr. (3 and 0)  
Design, construction and analysis of stochastic simulation models for typical management decisions; design; input-output; variance reduction; applications; validation; implementation; optimum seeking techniques; designed experiments; emphasis is on effect of model results on managerial policy decisions. **Prerequisite:** CP SC 150 or equivalent.



- MGT 915 SEMINAR IN BUSINESS-LEVEL STRATEGY FORMULATION AND IMPLEMENTATION**  
3 cr. (3 and 0)  
Theoretical and empirical foundations of business-level strategy research, focusing on how firms compete in a particular business; strategic typologies, the strategic management process, strategy-environment fit, organization performance, business-unit culture, and functional strategies and structure. **Prerequisite:** MGT 804.
- MGT 916 DIRECTED READINGS IN MANAGEMENT**  
1-3 cr. (1-3 and 0)  
Directed reading and research in the student's area of interest. May be repeated for a maximum of three credit hours. **Prerequisite:** Permission of instructor.
- MGT 918 SEMINAR IN MANAGEMENT SUPPORT SYSTEMS**  
3 cr. (3 and 0)  
Contemporary topics in decision-oriented information systems research; structure of the field, research methodologies and research opportunities. **Prerequisite:** MGT 818 or permission of instructor.
- MGT 921 SEMINAR IN THE SCIENCE AND PRACTICE OF BUSINESS AND ECONOMIC MODELING**  
3 cr. (3 and 0)  
Current literature used as a resource for studying and analyzing selected topics important in the design and development of simulation models; students lead and participate in group discussions. **Prerequisite:** MGT 913 or equivalent.
- MGT 950 SEMINAR IN CORPORATE-LEVEL STRATEGY FORMULATION AND IMPLEMENTATION**  
3 cr. (3 and 0)  
Theoretical and empirical foundations of corporate-level strategy research, emphasizing both formulation and implementation issues; boards of directors, decision making, diversification, strategic fit, mergers and acquisitions, divestitures, joint ventures and corporate structure. **Prerequisite:** MGT 804.
- MGT 952 SEMINAR IN MANUFACTURING AND OPERATIONS STRATEGY**  
3 cr. (3 and 0)  
Emerging theoretical and empirical research showing the linkages among competitive business priorities, patterns of operations decisions and firm performance. Topics include development of operations objectives and strategies that reflect competitive priorities, and strategic operations decisions in the areas of process, capacity, facility, and planning and control systems. **Prerequisite:** MGT 804.
- MGT 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.
- H ADM 608 HOSPITAL AND HEALTH SERVICES ADMINISTRATION**  
3 cr. (3 and 0)

- H ADM 610 HOSPITAL INTERNSHIP**  
3 cr. (0 and 9)

### Management Science

Peter R. Nelson, Program Coordinator, Department of Mathematical Sciences

Major	Degree
Management Science	Ph.D.

The departments of Management and Mathematical Sciences (College of Engineering and Science) jointly offer and administer this program. Applicants should have a demonstrated aptitude for quantitative analysis and a primary interest in scientific management research and practice. The program is for persons interested in using and developing the growing array of statistical and quantitative decision-making techniques used by the larger and more sophisticated American, foreign and multinational firms. Such techniques include probability models; statistical analysis; linear, nonlinear and dynamic programming; and decision theory.

The program structure blends courses in statistical theory, operations research and functional areas of management to provide a balanced offering of advanced work in each field contributing to the degree.

- MA SC 807 ECONOMETRICS II**  
(ECON 807) 3 cr. (3 and 0) F  
(AP EC 807) See ECON 807 for description.
- MA SC 808 ECONOMETRICS III**  
(ECON 808) 3 cr. (3 and 0) S  
(AP EC 808) See ECON 808 for description.
- MA SC 810 FOUNDATIONS OF MANAGEMENT SCIENCE**  
3 cr. (3 and 0) S  
Fundamental management science modeling techniques, emphasizing problem formulation, computer solution and economic analysis in an operations context; concepts include queuing analysis, computer simulation and mathematical programming approaches including linear, goal and integer programming; application areas encompass production, capacity and project planning, scheduling, location, layout and logistics. **Prerequisite:** MGT 803 or equivalent.
- MA SC 812 MANAGEMENT SCIENCE II**  
3 cr. (3 and 0) F  
Continuation of MA SC 810; dynamic, integer and nonlinear programming, emphasizing applications of different types of mathematical programming to business and industrial problems. **Prerequisite:** MA SC 810 or permission of instructor.
- MA SC 814 DESIGN OF EXPERIMENTS IN BUSINESS AND MANAGEMENT**  
3 cr. (3 and 0) S  
Design and analysis of experiments with a focus on business and industrial applications; topics range from the analysis of single-factor experimental designs through factorial experiments, multiple comparisons and confounding; problems arising in the actual industrial environments are used to illustrate the application of the techniques and to introduce the student to major statistical software packages for the analysis of experimental data.



Management science students are required to take some of the following courses offered by various departments. Descriptions for all 800-level courses are under the respective departmental headings.

<b>MGT 801</b>	<b>PRODUCTION AND PRICING ANALYSIS</b> 3 cr. (3 and 0)
<b>MGT 803</b>	<b>OPERATIONS MANAGEMENT</b> 3 cr. (3 and 0) F
<b>MGT 804</b>	<b>MANAGERIAL POLICY</b> 3 cr. (3 and 0) F
<b>MGT 807</b>	<b>COMPARATIVE MANAGEMENT THEORY</b> 3 cr. (3 and 0)
<b>MGT 809</b> <b>(M B A 809)</b>	<b>ORGANIZATION THEORY AND BEHAVIOR</b> 3 cr. (3 and 0) F
<b>MGT 910</b>	<b>SEMINAR IN OPERATIONS MANAGEMENT</b> 1-3 cr. (1-3 and 0)
<b>MGT 911</b>	<b>SEMINAR IN DECISION THEORY</b> 1-3 cr. (1-3 and 0)
<b>MGT 913</b>	<b>MANAGEMENT SYSTEMS ANALYSIS</b> 3 cr. (3 and 0)
<b>MTHSC 606</b>	<b>SAMPLING THEORY AND METHODS</b> 3 cr. (3 and 0)
<b>MTHSC 641</b>	<b>INTRODUCTION TO STOCHASTIC MODELS</b> 3 cr. (3 and 0)
<b>MTHSC 800</b>	<b>PROBABILITY</b> 3 cr. (3 and 0) F
<b>MTHSC 801</b>	<b>GENERAL LINEAR HYPOTHESIS I</b> 3 cr. (3 and 0) F
<b>MTHSC 802</b>	<b>GENERAL LINEAR HYPOTHESIS II</b> 3 cr. (3 and 0) S
<b>MTHSC 803</b>	<b>STOCHASTIC PROCESSES</b> 3 cr. (3 and 0) S, SS
<b>MTHSC 805</b>	<b>DATA ANALYSIS</b> 3 cr. (3 and 0) F, S
<b>MTHSC 809</b>	<b>TIME SERIES ANALYSIS, FORECASTING AND CONTROL</b> 3 cr. (3 and 0) F
<b>MTHSC 810</b>	<b>MATHEMATICAL PROGRAMMING</b> 3 cr. (3 and 0) F, S
<b>MTHSC 811</b>	<b>NONLINEAR PROGRAMMING</b> 3 cr. (3 and 0) S
<b>MTHSC 813</b>	<b>ADVANCED LINEAR PROGRAMMING</b> 3 cr. (3 and 0) S
<b>MTHSC 814</b>	<b>NETWORK FLOW PROGRAMMING</b> 3 cr. (3 and 0) F
<b>MTHSC 817</b>	<b>STOCHASTIC MODELS IN OPERATIONS RESEARCH I</b> 3 cr. (3 and 0) F

**MTHSC 818**      **STOCHASTIC MODELS IN OPERATIONS RESEARCH II**  
3 cr. (3 and 0) S

**MTHSC 860**      **AN INTRODUCTION TO SCIENTIFIC COMPUTING**  
3 cr. (3 and 0) S, SS

**MTHSC 881**      **MATHEMATICAL STATISTICS**  
3 cr. (3 and 0) S

**MTHSC 907**      **MULTIVARIATE ANALYSIS**  
3 cr. (3 and 0) N

### Marketing

Richard M. Reese, Chair, Department of Marketing

Advanced degrees are not awarded in marketing. Courses are offered to provide electives for students in other areas.

**MKT 627**      **INTERNATIONAL MARKETING**  
3 cr. (3 and 0)

**MKT 629**      **PUBLIC AND NONPROFIT MARKETING**  
3 cr. (3 and 0)

**MKT 630**      **MARKETING PRODUCT MANAGEMENT**  
3 cr. (3 and 0)

**MKT 631**      **MARKETING RESEARCH**  
3 cr. (3 and 0)

**MKT 638**      **TECHNICAL MARKETING**  
3 cr. (3 and 0)

**MKT 695**      **SELECTED TOPICS**  
3 cr. (3 and 0)

### School of Social Science

#### Applied Sociology

John W. Ryan, Chair, Department of Sociology

<b>Major</b>	<b>Degree</b>
Applied Sociology	M.S.

The Department of Sociology offers the M.S. degree in applied sociology, emphasizing practical and theoretical knowledge in the areas of industrial and organizational sociology, and focusing on the acquisition of social research skills, theory application and practical field experience. Students are prepared for employment in federal, state and local government agencies; in industry and related agencies; and to pursue a doctorate.

Applicants must hold a bachelor's degree from an accredited degree program; have completed a minimum of 15 undergraduate semester hours in sociology or another social science discipline that includes at least one course each in statistics, research methods and sociological theory; submit GRE scores on the verbal, quantitative and analytical sections (satisfactory scores normally include a minimum of 500 on each section of the test); submit three letters of recommendation, at least two of which are from faculty members of the applicant's previously attended college or university; and submit a 500-word essay on career aspirations and goals, and explain how completion of this program in applied sociology will assist in achieving these goals.

All students are required to write a thesis and to complete a minimum of 40 hours of course work, including SOC 803, 805, 807, 810, 830, 833, 895 and selected electives. Students must



demonstrate competency in basic statistics in the first semester by either passing a departmentally administered competency examination or obtaining a grade of B in EX ST 801. Students also must demonstrate competency in multivariate regression in the second semester by either passing a departmentally administered competency examination or obtaining a grade of B in MTHSC 805. The 40-hour requirement includes a six-hour placement in an applied setting. The field placement is coordinated by the student, the graduate director and the on-site supervisor. Typically, the internship is completed in the summer between the first and second year of the program, but only after completing a minimum of 12 credit hours of 800-level course work. In exceptional circumstances the graduate coordinator may approve the substitution of six hours of appropriate course work for the field placement when the student has had work experience comparable to the placement.

<b>SOC 601</b> (R S 601)	<b>HUMAN ECOLOGY</b> 3 cr. (3 and 0) S
<b>SOC 604</b>	<b>SOCIOLOGICAL THEORY</b> 3 cr. (3 and 0)
<b>SOC 630</b>	<b>SOCIOLOGY OF ORGANIZATIONS</b> 3 cr. (3 and 0)
<b>SOC 633</b>	<b>DEVELOPING SOCIETIES</b> 3 cr. (3 and 0)
<b>SOC 640</b>	<b>LEISURE, THE MASS MEDIA AND CULTURE</b> 3 cr. (3 and 0)
<b>SOC 641</b>	<b>SOCIOLOGY OF SPORT</b> 3 cr. (3 and 0)
<b>SOC 660</b>	<b>RACE, ETHNICITY AND CLASS</b> 3 cr. (3 and 0)
<b>SOC 662</b>	<b>MEN, MASCULINITY AND SOCIETY</b> 3 cr. (3 and 0)
<b>SOC 663</b>	<b>SOCIOLOGY OF PARENTING</b> 3 cr. (3 and 0)
<b>SOC 671</b> (R S 671)	<b>DEMOGRAPHY</b> 3 cr. (3 and 0) F
<b>SOC 680</b>	<b>MEDICAL SOCIOLOGY</b> 3 cr. (3 and 0)
<b>SOC 681</b>	<b>AGING AND DEATH</b> 3 cr. (3 and 0)
<b>SOC 684</b>	<b>CHILD ABUSE AND TREATMENT</b> 3 cr. (3 and 0)
<b>SOC 803</b>	<b>SURVEY DESIGNS FOR APPLIED SOCIAL RESEARCH</b> 3 cr. (3 and 0) F Survey research design principles, procedures and techniques used in applied sociology; emphasis is on instrumentation, data collection and management, and their interpretation. <b>Prerequisite:</b> SOC 303 or equivalent.
<b>SOC 805</b>	<b>EVALUATION RESEARCH</b> 3 cr. (3 and 0) S Research methods and techniques of computer-assisted data management and analyses used in evaluating policies, operation, organi-

zation and effectiveness of social programs in the private and public sectors; special emphasis is on microcomputer software packages available for these purposes. **Prerequisite:** SOC 803.

<b>SOC 807</b>	<b>ADVANCED RESEARCH METHODS</b> 3 cr. (3 and 0) S Advanced methods in social research; consideration of various measuring techniques and data analysis strategies; practical experience in various phases of social research. <b>Prerequisite:</b> SOC 803.
<b>SOC 810</b>	<b>THEORETICAL MODELS IN APPLIED SOCIAL RESEARCH</b> 3 cr. (3 and 0) S Comparative analysis of theoretical models in sociology and their uses in applied research; particular attention is given to the uses of these models in research concerned with the processes of industrial and economic growth and development. <b>Prerequisite:</b> SOC 404 or equivalent.
<b>SOC 812</b>	<b>SEMINAR ON MARRIAGE AND THE FAMILY</b> 3 cr. (3 and 0) N Current family research and theory in areas such as problem-solving strategies, developmental processes, family and work life, changes throughout the lifespan, including premarital sexuality, pregnancy, divorce, marriage enrichment and courtship. Topics vary from year to year. May be repeated for credit. <b>Prerequisite:</b> SOC 311 or equivalent.
<b>SOC 814</b>	<b>POLICY AND SOCIAL ACTION</b> 3 cr. (3 and 0) N Policy formation, implementation and evaluation in public and private sectors with a focus on outcomes of policy formation, social planning and implementation. <b>Prerequisite:</b> SOC 810 or permission of instructor.
<b>SOC 830</b>	<b>HUMAN SYSTEMS DEVELOPMENT: ORGANIZATIONS AND SOCIETY</b> 3 cr. (3 and 0) F Complex organizations such as human systems, with primary focus on development and change, interorganizational relations, and the influence of these structures on the community life. <b>Prerequisite:</b> SOC 430 or equivalent.
<b>SOC 833</b>	<b>WORK AND SOCIETY</b> 3 cr. (3 and 0) S The history of industrial development and its consequences at the societal, community and individual levels; current issues involved in the relationship between work and society, and strategies for developing research and policy related to these issues. <b>Prerequisite:</b> SOC 330 or equivalent.



- SOC 835 SEMINAR ON WORK, LEISURE AND THE FAMILY**  
3 cr. (3 and 0) N  
Current topics and research on work, leisure and the family vary from year to year. May be repeated for credit. **Prerequisite:** SOC 830 or 833.
- SOC 882 SYSTEMS OF MARITAL AND FAMILY THERAPY**  
3 cr. (3 and 0)  
Theories and techniques of marital and family therapy. **Prerequisite:** Permission of instructor.
- SOC 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- SOC 892 SELECTED TOPICS IN SOCIOLOGY**  
3 cr. (3 and 0) N  
Current topics in applied sociology not covered in other graduate courses. May be repeated once for credit.
- SOC 895 FIELD EXPERIENCE**  
3-6 cr. SS  
Supervised full-time work experience in a public agency or private enterprise to gain planning, research and policy experience. May not be repeated for credit. Graded on a pass/fail basis. **Prerequisite:** 12 hours of 800-level course work in sociology.
- SOC 896 INDEPENDENT STUDY**  
1-3 cr. (1-3 and 0)  
Individual readings or research in a topic area selected according to a student's interests or program needs. May be repeated for up to six hours. Graded on a pass/fail basis. **Prerequisite:** Approval of the director of graduate studies.
- ANTH 601 CULTURES AND THE ENVIRONMENT**  
3 cr. (3 and 0)
- ANTH 603 QUALITATIVE METHODS**  
3 cr. (3 and 0)

### Political Science

Martin W. Slann, Chair, Department of Political Science

Major	Degree
Public Administration	M.P.A.

Advanced degrees are not awarded in political science. Courses are offered at the 600 level to provide electives for students in other areas.

The department participates with the Department of Government and International Relations at the University of South Carolina in offering the joint professional degree, Master of Public Administration. Courses for this program are taught only at the University Center of Greenville, S.C.

From 36 to 45 semester hours are required for the M.P.A. degree, depending on the student's background. Students lacking proficiency in statistics or American government are required to take prerequisites in one or both areas. Students who do not have substantial administrative experience are required to complete an internship encompassing at least three months of full-time administrative work. All M.P.A. students must complete six core courses (PO SC 821, 822, 827, 829, 834 and 841), a core course

that focuses on the level of government (e.g., local, state, etc.) in which the student is interested, and five electives.

- PO SC 604 GENDER AND POLITICS**  
3 cr. (3 and 0)
- PO SC 609 DIRECTED STUDY IN AMERICAN INSTITUTIONS**  
3 cr. (3 and 0)
- PO SC 623 URBAN POLITICS**  
3 cr. (3 and 0)
- PO SC 626 TOTAL QUALITY MANAGEMENT IN THE PUBLIC SECTOR**  
3 cr. (3 and 0)
- PO SC 627 PUBLIC PERSONNEL MANAGEMENT**  
3 cr. (3 and 0)
- PO SC 628 NATIONAL SECURITY POLICY**  
3 cr. (3 and 0)
- PO SC 632 AMERICAN CONSTITUTIONAL LAW I**  
3 cr. (3 and 0)
- PO SC 633 AMERICAN CONSTITUTIONAL LAW II**  
3 cr. (3 and 0)
- PO SC 642 POLITICAL PARTIES AND ELECTIONS**  
3 cr. (3 and 0)
- PO SC 654 SOUTHERN POLITICS**  
3 cr. (3 and 0)
- PO SC 657 POLITICAL TERRORISM**  
3 cr. (3 and 0)
- PO SC 658 POLITICAL LEADERSHIP**  
3 cr. (3 and 0)
- PO SC 662 INTERNATIONAL LAW AND ORGANIZATIONS**  
3 cr. (3 and 0)
- PO SC 663 UNITED STATES FOREIGN POLICY**  
3 cr. (3 and 0)
- PO SC 702 METHODS FOR PUBLIC MANAGEMENT**  
3 cr. (3 and 0)  
Use of social science research methods in addressing issues in public management and policy; research design; measurement; data collection; sampling and polling; use of statistical procedures in policy studies and decision-making theory.
- PO SC 821 PERSPECTIVES ON PUBLIC ADMINISTRATION**  
3 cr. (3 and 0)  
Study and practice of public administration in the United States in the twentieth century; examination of the historical development of the field of public administration and current approaches to the study and practice of public administration.



- PO SC 822 PUBLIC POLICY PROCESS**  
3 cr. (3 and 0)  
Major models of policy making, including incrementalism, rationalism, pluralism and elitism; selected areas of public policy, including transportation, poverty, energy and the environment.
- PO SC 827 PUBLIC PERSONNEL ADMINISTRATION**  
3 cr. (3 and 0)  
Organization, techniques and theories of personnel management; interpersonal relations in organizations; personnel change and development; changing conditions in the public service: educational specializations, unions, collective bargaining, etc.; ethics for the public service.
- PO SC 829 PUBLIC FINANCIAL MANAGEMENT**  
3 cr. (3 and 0)  
Organization and techniques of governmental financial management; budgetary theories; intergovernmental financial relations.
- PO SC 830 CONSTITUTIONAL LAW FOR PUBLIC ADMINISTRATION**  
3 cr. (3 and 0)  
Principles of American constitutional law, with particular attention to legal issues related to public administration, including delegation of power, separation of powers, due process, and civil rights and liberties. May not be taken for credit by students who have taken PO SC 632 or 633, or their equivalents.
- PO SC 834 ADMINISTRATIVE LAW**  
3 cr. (3 and 0)  
Study of the legislative, adjudicatory and general policy-making powers of administrative agencies and regulatory commissions, and the scope of judicial review of administrative action; directed primarily toward the analysis of the political nature of bureaucracy.
- PO SC 841 PUBLIC DATA ANALYSIS**  
3 cr. (3 and 0)  
Various aspects of locating, collecting and processing primary and secondary data utilized by public administrators and policy analysts, including design of original surveys, library and archive searches, problems of storage and retrieval, and statistical description.  
**Prerequisite:** EX ST 301, MTHSC 301 or equivalent.
- PO SC 860 AMERICAN GOVERNMENT**  
3 cr. (3 and 0)  
Introduction and overview of the literature of the American political system, its institutions and processes.
- PO SC 867 STATE GOVERNMENT ADMINISTRATION**  
3 cr. (3 and 0)  
State government problems and policy issues, emphasizing the modernization of government institutions and comparative state politics.

- PO SC 868 LOCAL GOVERNMENT ADMINISTRATION**  
3 cr. (3 and 0)  
Administration of local government from the perspective of the professional administrator, emphasizing the growth of the manager form of local government and the role of local government administrators with regard to policy making, management and the delivery of services.
- PO SC 877 PUBLIC POLICY EVALUATION SEMINAR**  
3 cr. (3 and 0)  
Conceptual and analytic issues in policy and program evaluation, including problem definition, goal setting and criteria formulation; design of evaluation research; indicator design; treatment of uncertainty; and special problems raised by constraints of the political context.
- PO SC 878 SELECTED TOPICS IN PUBLIC ADMINISTRATION**  
3 cr. (3 and 0)  
In-depth study of an applied problem in public administration as seen through the practitioner's eyes, and the methods used to address these problems.
- PO SC 879 INTERNSHIP IN PUBLIC ADMINISTRATION**  
1-3 cr. (1-3 and 0)  
Students serve an internship with a government agency; a written report must be submitted detailing the experience.
- PO SC 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- These courses in Government and International Studies (GINT) are offered at the University Center of Greenville as part of the core courses in the joint program for the professional degree, Master of Public Administration.*
- GINT 767 STATE GOVERNMENT**  
3 cr. (3 and 0)  
State government problems and policy issues, emphasizing the modernization of government institutions and comparative state politics.
- GINT 771 PUBLIC DATA ANALYSIS**  
3 cr. (3 and 0)  
Problems of gathering and using public data for public administrators and policy analysts, including problems of research design and data gathering, interpretation and use in the analysis of public programs.
- GINT 773 PERSONNEL ADMINISTRATION**  
3 cr. (3 and 0)  
Organization, techniques and theories of personnel management; interpersonal relations in organizations; personnel change and development; changing conditions in the public service; educational specialization, unions, collective bargaining, etc.; ethics for public service.
- GINT 774 THE PUBLIC POLICY PROCESS**  
3 cr. (3 and 0)  
The public policy process, including the role of public officials in the process, and constraints on its outcomes.



## Psychology

Eugene H. Galluscio, Chair, Department of Psychology

Majors	Degrees
Applied Psychology	M.S.
Industrial/Organizational Psychology	Ph.D.

The Department of Psychology offers a Ph.D. degree in industrial/organizational psychology and an M.S. degree in applied psychology with concentrations in industrial/organizational psychology and human factors psychology. These programs are designed to provide the student with the requisite theoretical foundations, skills in quantitative techniques and research design, and practical problem-solving skills to address human problems related to work. The Department of Psychology is a member of the Council on Applied Master's Programs in Psychology.

Applicants to these programs should have an undergraduate degree with a major in psychology or a related field from an accredited college or university. Students with a major other than psychology should have a minimum of 15 semester hours beyond the introductory psychology survey course.

A formal thesis and supervised field internship are required for the M.S. degree. M.S. students complete 45 semester hours, including six semester hours of thesis credit and six semester hours of credit for the internship. Typically, the internship is completed in the summer between the first and second years of the program. In some cases, six semester hours of approved electives may be substituted for the field internship.

Students in the doctoral program are expected to satisfy the master's program requirements prior to receiving their doctorate. In addition to the required core content courses, a doctoral program must include at least one course from each of four major areas of psychology (biological, cognitive-affective, social, individual differences). In addition, 18 hours of dissertation research are required. Students are admitted to candidacy for the Ph.D. degree upon successful completion of a qualifying examination.

PSYCH 615	<b>SYSTEMS AND THEORIES OF PSYCHOLOGY</b> 3 cr. (3 and 0)
PSYCH 626	<b>ADVANCED PHYSIOLOGICAL PSYCHOLOGY</b> 3 cr. (3 and 0)
PSYCH 635	<b>HUMAN FACTORS PSYCHOLOGY</b> 3 cr. (3 and 0)
PSYCH 659	<b>GROUP DYNAMICS</b> 3 cr. (3 and 0)
PSYCH 662	<b>PSYCHOLOGY AND CULTURE</b> 3 cr. (3 and 0)
PSYCH 680	<b>HEALTH PSYCHOLOGY</b> 3 cr. (3 and 0)
PSYCH 683	<b>ABNORMAL PSYCHOLOGY</b> 3 cr. (3 and 0)
PSYCH 689	<b>SELECTED TOPICS</b> 3 cr. (3 and 0)
PSYCH 801	<b>PROFESSIONAL ETHICS IN INDUSTRIAL/ORGANIZATIONAL PSYCHOLOGY</b> 2 cr. (2 and 0) Ethics and standards for the practice of psychology in organizations, emphasizing applied situations in organizational settings and in research. <b>Prerequisite:</b> Permission of instructor.

PSYCH 810	<b>RESEARCH DESIGN AND QUANTITATIVE METHODS I</b> 3 cr. (3 and 0) Bivariate and multivariate data analysis applied to industrial and other work-related settings. Topics include the major data analytic tools needed for research in applied psychology. <b>Prerequisite:</b> Six credits of statistics, research methods or equivalent.
PSYCH 811	<b>RESEARCH DESIGN AND QUANTITATIVE METHODS II</b> 3 cr. (3 and 0) Research methodologies; experimental, quasi-experimental and nonexperimental designs, emphasizing applied psychological research. Special topics include scientific method, basic versus applied research, technical writing, grant writing and ethics. <b>Prerequisite:</b> PSYCH 810.
PSYCH 815	<b>ADVANCED STUDIES IN SYSTEMS AND THEORIES</b> 3 cr. (3 and 0) Advanced study of the foundations of contemporary psychology, the origins of major theories, the conceptions of scientific knowledge implicit in them, and the reasons for accepting or rejecting them. <b>Prerequisite:</b> PSYCH 415 or permission of instructor.
PSYCH 822	<b>HUMAN PERCEPTION AND PERFORMANCE</b> 3 cr. (3 and 0) Basic research on human perception as applied to task performance; focus is on vision and audition in adults, examining basic knowledge of human sensory and perceptual characteristics as applied to such tasks as machine operation, task performance, etc.
PSYCH 833	<b>COGNITIVE PSYCHOLOGY</b> 3 cr. (3 and 0) Research and theory concerning perception, memory, reasoning, problem solving, knowledge representation, psychology of language, semantics, attention, concept formation and other high-level mental processes; applications of these areas are considered.
PSYCH 837	<b>ERGONOMICS FOR APPLIED PSYCHOLOGY</b> 3 cr. (3 and 0) Perception and action capabilities of humans as they relate to the design of machines and environments; biomechanics, anthropometry, human movement and work, and the perceptual supports action.
PSYCH 845	<b>ADVANCED STUDIES IN ADULTHOOD AND AGING</b> 3 cr. (3 and 0) Advanced study of human development from young adulthood through late adulthood; biological, cognitive, personality development and social development, examined from the perspective of several major theoretical frameworks. <b>Prerequisite:</b> PSYCH 345 or permission of instructor.



- PSYCH 852 ADVANCED STUDIES IN SOCIAL PSYCHOLOGY**  
3 cr. (3 and 0)  
Human social behavior from the perspective of the individual as a participant in social relationships, emphasizing contemporary theories of human social behavior and human behavior in social settings. **Prerequisite:** PSYCH 352 or permission of instructor.
- PSYCH 860 PSYCHOLOGY OF TRAINING AND EVALUATION**  
3 cr. (3 and 0)  
Evaluation issues such as criteria development, organizational assessment, process and outcome criteria along with instructional methodologies, such as fairness in training, special populations, second careers, hard-core unemployment, and ethics of organizational and industrial change. **Prerequisite:** A course in industrial psychology, personnel psychology or equivalent.
- PSYCH 861 PERSONNEL PSYCHOLOGY**  
3 cr. (3 and 0)  
Theory, techniques and legal issues involved in the effective matching of individuals' needs, preferences, skills and abilities with the needs and preferences of organizations. Topics include research methods, prediction issues, tests and other predictors, decision making and job evaluation. **Prerequisite:** PSYCH 810.
- PSYCH 862 ORGANIZATIONAL DEVELOPMENT**  
3 cr. (3 and 0)  
Forms of organizational structure and basic theories of organizations; theories and technologies of organizational development and change are stressed; course analyzes the relationships between organizational design and technology. **Prerequisite:** A course in industrial/organizational psychology or equivalent.
- PSYCH 863 WORK MOTIVATION AND SATISFACTION**  
3 cr. (3 and 0)  
Explanations for absenteeism, productivity, job satisfaction and withdrawal, as well as their interrelations; methods of measuring attitudes and opinions and general theories of human motivation. **Prerequisite:** An industrial/organizational psychology course or equivalent.
- PSYCH 864 PERFORMANCE APPRAISAL**  
3 cr. (3 and 0)  
Job measurement and the psychological processes involved in performance appraisal, emphasizing current methods, theory and applications in the measurement of job performance; training in the development and evaluation of performance appraisal systems. **Prerequisite:** PSYCH 364 or permission of instructor.
- PSYCH 865 JOB ANALYSIS**  
3 cr. (3 and 0)  
Applied and theoretical issues in the analysis of work; structured techniques for person and job-oriented analyses; applications of job analysis in the areas of test development, performance appraisal and job evaluation. **Prerequisite:** PSYCH 364 or equivalent or permission of instructor.
- PSYCH 866 ATTITUDE MEASUREMENT THEORY**  
3 cr. (3 and 0)  
Classic and contemporary approaches to attitude theory, measurement and scaling techniques with special emphasis on theories of job satisfaction and the measurement of attitudes toward work. **Prerequisite:** PSYCH 471 or permission of instructor.
- PSYCH 871 PSYCHOLOGICAL TESTS AND MEASUREMENT**  
3 cr. (3 and 0)  
Advanced survey of psychological test development, evaluation and utilization in organizational and research settings; professional guidelines for the practice of testing in industrial/organizational psychology and legal guidelines for using tests in industry. **Prerequisite:** Permission of instructor.
- PSYCH 883 ADVANCED STUDIES IN ABNORMAL PSYCHOLOGY**  
3 cr. (3 and 0)  
Seminar on the etiology and classification of abnormal behavior, emphasizing empirical and theoretical issues in the understanding of mental disorders; cultural influences on judgment of abnormality and in-depth examination of specific psychological disorders. **Prerequisite:** PSYCH 483 or permission of instructor.
- PSYCH 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- PSYCH 895 APPLIED PSYCHOLOGY INTERNSHIP**  
3-6 cr. (0 and 3-6)  
Supervised field experience in industry, business or government; site location, on-site supervision and credit hours must be approved in advance by the graduate coordinator.
- PSYCH 897 SPECIAL PROBLEMS IN APPLIED PSYCHOLOGY**  
1-3 cr. (1-3 and 0)  
Study of a particular topic under the direction of a faculty member; specific program is organized by the student and faculty member and submitted to the graduate coordinator for approval; project is not used to support M.S. thesis. May be repeated for a maximum of six credits.
- PSYCH 898 INDUSTRIAL/ORGANIZATIONAL PSYCHOLOGY**  
3 cr. (3 and 0)  
Contemporary topics in industrial/organizational psychology. **Prerequisite:** Permission of instructor.
- PSYCH 899 SELECTED TOPICS**  
3 cr. (3 and 0)  
Selected current and classic topics not covered in other courses. May be repeated for credit.
- PSYCH 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.



School of Chemical and Materials Engineering • 106

- Bioengineering • 106
- Ceramic Engineering • 108
- Chemical Engineering • 109
- Materials Science and Engineering • 111

School of the Environment • 112

- Environmental Science and Policy • 112
- Environmental Systems Engineering • 113
- Environmental Toxicology • 115
- Hydrogeology • 115

School of Mechanical and Industrial Engineering • 117

- Engineering Graphics • 117
- Engineering Mechanics • 117
- Industrial Engineering • 118
- Mechanical Engineering • 120

School of Textiles, Fiber and Polymer Science • 123

- Textile and Polymer Science • 123
- Textile Chemistry • 123
- Textile Science • 124

Agricultural Engineering • 125

Chemistry • 126

Civil Engineering • 128

Computer Engineering • 131

Computer Science • 133

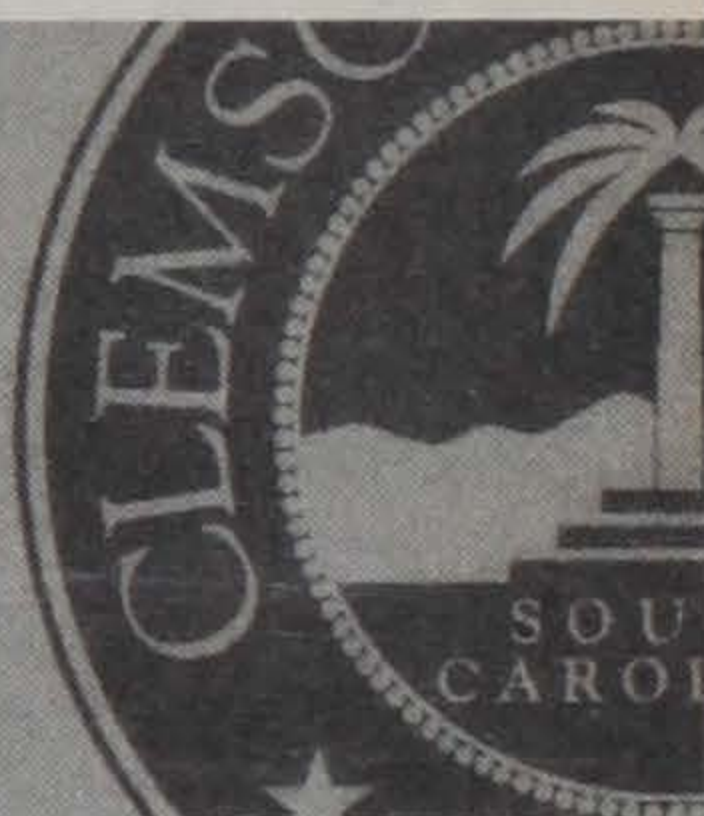
Electrical Engineering • 136

Management Science • 140

Mathematical Sciences • 140

Physics • 146

COLLEGE OF  
ENGINEERING AND  
SCIENCE





## COLLEGE OF ENGINEERING AND SCIENCE

Thomas M. Keinath, Dean

The College of Engineering and Science offers advanced degrees in these areas of study.

Agricultural Engineering\*  
Bioengineering  
Ceramic Engineering  
Chemical Engineering  
Chemistry  
Civil Engineering  
Computer Engineering  
Computer Science  
Electrical Engineering  
Engineering Mechanics  
Environmental Systems Engineering  
Environmental Toxicology\*\*  
Hydrogeology  
Industrial Engineering  
Management Science\*\*\*  
Materials Science and Engineering  
Mathematical Sciences  
Mechanical Engineering  
Physics  
Textile and Polymer Science  
Textile Chemistry  
Textile Science

Courses are offered in astronomy, engineering graphics, and environmental science and policy to provide electives for students in other areas.

Degrees offered are the Master of Engineering, Master of Science and Doctor of Philosophy. Precise offerings in each area are found in the individual departmental or program descriptions.

The M.S. and Ph.D. programs serve primarily full-time graduate students. Industrial Residency Programs leading to the Master of Science degree are available in certain engineering departments. Financial aid, in the form of full and partial fellowships and teaching and research assistantships, is available. Other financial aid packages are available to outstanding applicants. A broad and vigorous research program provides excellent thesis and dissertation research opportunities. Details on current research projects and special facilities are available from the various departments.

The Master of Engineering program is open to individuals who are interested in professionally oriented advanced study. Requirements for the program are a baccalaureate degree from an ABET-accredited engineering program or equivalent, academic and professional records which indicate motivation for and the ability to complete additional professional study, and acceptance by the head of the department in which the individual plans to major and by the dean of the College of Engineering and Science.

The college offers cooperative graduate programs in which semesters of on-campus study are alternated with work assignments in industry.

The Clemson University Master of Engineering Program at The Citadel offers high quality graduate engineering education in the South Carolina Lowcountry. With few exceptions, the stu-

dents are practicing engineers pursuing graduate education part-time in the evening hours. Currently courses are offered in civil engineering in the subject areas of structural, water resources and construction engineering. Information about courses and registration can be obtained by writing to Clemson University Master of Engineering Program at The Citadel, P.O. Box 12099, Charleston, SC 29422-2099, or by calling (803) 953-2242. The Master of Science degree program in civil engineering, both thesis and non-thesis options, is offered at The Citadel.

### *School of Chemical and Materials Engineering*

R. Larry Dooley, Director

### **Bioengineering**

R. Larry Dooley, Chair, Department of Bioengineering

Major	Degrees
Bioengineering	M.S., Ph.D.

The bioengineering program is devoted to the application of engineering science, methods and techniques to problems ranging from basic biomedical research to applied health care delivery. The principle area of concentration is biomaterials, engineering and related fields, including biomechanics and research instrumentation. The traditionally strong emphasis in the areas of materials and mechanics is directed toward the development of materials and devices (including artificial organs) for surgical implantation. Artificial intelligence is applied to medical diagnostic problems and to assist in the design, evaluation and fabrication of custom implants. Heavy reliance is placed on considerable direct laboratory experience.

The faculty is augmented by adjunct medical faculty, and most research programs are conducted in collaboration with medical, clinical or research-oriented institutions. All students have some direct experience with an appropriate aspect of this medical involvement. A three-month clinical internship is available to all students through the Bioengineering Alliance of South Carolina.

Students enrolling in this program usually have a strong background in the more traditional engineering disciplines. Some background in general biology and physiology is recommended but is not a prerequisite. Students with degrees in science may be considered for admission if they can demonstrate proficiency in certain prescribed engineering courses.

Candidates are allowed flexibility in planning their programs, but they are encouraged to seek advice and direction from the faculty because of the rapid evolution of this emerging discipline.

The master's degree curriculum offers both a thesis and a nonthesis option. The thesis option requires a minimum of 30 semester hours including six semester hours of research. The nonthesis option requires a minimum of 33 semester hours including six semester hours of nonthesis research, special topics or internship, and a report. Both options require a final examination.

<b>BIO E 650</b>	<b>SPECIAL TOPICS IN BIOMEDICAL ENGINEERING</b> 1-4 cr.
------------------	--

<b>BIO E 680</b> <b>(CR E 680)</b>	<b>RESEARCH PRINCIPLES</b> 1 cr. (1 an 0)
---------------------------------------	--

<b>BIO E 800</b>	<b>SEMINAR IN BIOENGINEERING RESEARCH</b> 1 cr. (2 and 0)
------------------	--

Original research in bioengineering; weekly one hour seminar associated with weekly recitation covering seminar preparation, presentation, professional writing, bioengineering ethics and related topics. Graded on a pass/fail basis.

\* This program is administered jointly by the College of Engineering and Science and the College of Agriculture, Forestry and Life Sciences. The degrees are awarded by the College of Engineering and Science.

\*\* This program is administered jointly by the College of Agriculture, Forestry and Life Sciences and the College of Engineering and Science.

\*\*\* This program is administered jointly by the Department of Management (College of Business and Public Affairs) and the Department of Mathematical Sciences. The Ph.D. is awarded by the College of Business and Public Affairs.



- BIO E 801 BIOMATERIALS**  
3 cr. (3 and 0)  
Structure and properties of the main classes of materials used in artificial organs and surgical implants; metals, ceramics, polymers, composites and materials of biological origin; mechanical properties, corrosion and design are emphasized. **Prerequisite:** M E 204, CR E 310 or equivalent, or permission of instructor.
- BIO E 802 COMPATIBILITY OF BIOMATERIALS**  
3 cr. (1 and 6)  
Techniques employed in determining compatibility of biomaterials with the physiological environment; optical microscopy, microradiography and ultraviolet fluorescence; normal histology of tissues, basic pathological reactions and tissue reactions to materials.
- BIO E 803 POLYMERIC BIOMATERIALS**  
3 cr. (3 and 0)  
Interplay of physicochemical properties of polymeric materials and the design of biomedical devices and their in vitro and in vivo performance; critical manufacturing aspects of selected augmentation and prosthetic devices for soft and hard tissues; analysis of case studies and reports on recent research findings. **Prerequisite:** Permission of instructor.
- BIO E 804 METALLIC AND CERAMIC IMPLANT MATERIALS**  
3 cr. (3 and 0)  
Interaction between implant material and host tissue, selection of materials for different applications, influences of material and host tissue performance on implant design and on in vitro testing of implant materials and devices. **Prerequisites:** CR E 310, BIO E 801 and permission of instructor.
- BIO E 805 COMPOSITE BIOMATERIALS**  
3 cr. (3 and 0)  
Mechanics of fiber-reinforced composite materials and their use in the design of structural orthopaedic implants. Topics covered include macro- and micro-mechanics, materials considerations, biocompatibility, diffusion, environmental resistance, aging, sterilization and fracture behavior. **Prerequisite:** BIO E 820 or permission of instructor.
- BIO E 812 ORTHOPAEDIC ENGINEERING AND PATHOLOGY**  
3 cr. (3 and 0)  
Interdisciplinary study of orthopaedic cases (bone growth, bone remodeling, osteoarthritis, implant fixation and joint replacements); biomechanical, biomaterials and clinical diagnosis of failed implants (total joints, fracture fixation and spinal instrumentation); basic concepts of orthopaedic pathology for engineers. **Prerequisites:** BIO E 801, 802, 820 and 882 or permission of instructor.
- BIO E 820 STRUCTURAL BIOMECHANICS**  
3 cr. (3 and 0)  
Mechanical functions of the human body treated as an engineering structure and the devices used to assist and supplement these functions; movement of the musculoskeletal system; locomotion; gait; prehension; lifting; function of artificial limbs; orthopedic prostheses and braces; effect of vibration and impact on the body; mathematical and other models of the body. **Prerequisite:** Permission of instructor.
- BIO E 821 HUMAN DYNAMICS**  
3 cr. (3 and 1)  
Elements of kinetics and kinematics, anthropometry, body segment parameters, link segment model development and synthesis of human movement, muscle mechanics, sports mechanics, blood flow and other delivery systems, organ motion and other topics of particular interest to students, all with reference to the human body in health and disease. **Prerequisites:** BIO E 820 or equivalent and permission of instructor.
- BIO E 823 ARTIFICIAL CARDIAC ASSISTANCE AND REPLACEMENT**  
2 cr. (2 and 0)  
Medical and bioengineering aspects of artificial hearts and cardiac assist devices; physiology and pathological aspects of patients with need for such devices; history of artificial heart development; design aspects of current devices; state of the art in animal experiments and human preliminary trials. **Prerequisites:** BIO E 882 and BIOSC 459/659.
- BIO E 840 CREATIVE BIOMEDICAL ENGINEERING DESIGN**  
3 cr. (2 and 2)  
Design philosophy; product liability; need analysis and specifications; feasibility studies; patent law; creativity and inventions; modeling and decision making; design of devices and systems; computer-aided design and manufacture (CAD/CAM); optimization; reliability; human factors; students complete biomedical design project with hands-on CAD/CAM experience. **Prerequisite:** Permission of instructor.
- BIO E 846 BIOMEDICAL BASIS FOR ENGINEERED REPLACEMENT**  
3 cr. (3 and 0)  
Form and function of human organs; major systems discussed; examples of engineering repair and replacement methods presented in light of pathological or traumatic organ malfunction. Core course for all graduate students preferably during their first fall semester.
- BIO E 847 ELEMENTS OF BIOENGINEERING**  
4 cr. (4 and 0)  
Cardiovascular systems and regulation; physiology of blood, heart and organ blood flow; properties of blood as a fluid; fluid flow equations; turbulence; pulse propagation; respiration and control of breathing; gas exchange; heart-lung bypass devices; renal function and control; artificial kidney devices; heat flow and temperature regulation. **Prerequisite:** BIOSC 459/659.



- BIO E 850 SPECIAL TOPICS IN BIOMEDICAL ENGINEERING**  
1-4 cr. (0-4 and 12-0)  
Directed study of advanced topics in bioengineering intended to develop in-depth areas of particular student interest. Credit may be earned for more than one semester. **Prerequisite:** Permission of instructor.
- BIO E 870 BIOINSTRUMENTATION**  
3 cr. (2 and 2)  
Concepts and techniques of instrumentation in bioengineering, emphasizing effects of instrumentation on the biological system under investigation; transducers and couplers; data conversion; conditioning and transmission; experimental problems in acute and chronic procedures with static and dynamic subjects.
- BIO E 882 BIOMATERIALS IMPLANTOLOGY**  
4 cr. (2 and 6)  
All phases of experimental surgery, including selection of animal models, preparation of animals for surgery, general and special surgical techniques, and basic and applied instrumentation. **Prerequisite:** BIOSC 459/659 or equivalent.
- BIO E 890 INTERNSHIP**  
1-5 cr. (0 and 8-40)  
Observation and assignment in a medical college, dental college, hospital, veterinary clinic, dental clinic, health service or industrial department. Credit to be arranged. **Prerequisite:** Permission of department head.
- BIO E 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- BIO E 892 NONTHESIS INDEPENDENT STUDY IN BIOENGINEERING**  
1-6 cr.  
Independent study in bioengineering for work necessary to complete requirements for the Master of Science degree in bioengineering, nonthesis option. May be repeated for additional credit. Graded on a pass/fail basis.
- BIO E 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

*The following courses offered by various departments represent possible electives for the student in bioengineering. Descriptions for all 800-level courses are under the respective departmental headings.*

- AN PH 801 (BIOSC 801) ELECTRON MICROSCOPY OF BIOLOGICAL SPECIMENS**  
3 cr. (1 and 6) F, S
- BIOCH 606 PHYSIOLOGICAL CHEMISTRY**  
3 cr. (3 and 0)
- BIOCH 623 PRINCIPLES OF BIOCHEMISTRY**  
3 cr. (3 and 0)
- BIOSC 659 SYSTEMS PHYSIOLOGY**  
3 cr. (3 and 0)
- BIOSC 661 CELL BIOLOGY**  
3 cr. (3 and 0)

- CH E 820 (T C 820) COMPOSITE POLYMERIC MATERIALS**  
3 cr. (3 and 0) N
- E M 630 MECHANICS OF COMPOSITE MATERIALS**  
3 cr. (3 and 0)
- E M 831 THEORY OF ELASTICITY I**  
3 cr. (3 and 0)
- EX ST 801 STATISTICAL METHODS**  
4 cr. (3 and 3) F, S
- EX ST 805 DESIGN AND ANALYSIS OF EXPERIMENTS**  
3 cr. (3 and 0) F, S
- P S 825 IMMUNOBIOLOGY**  
3 cr. (3 and 0) S

### Ceramic Engineering

H. David Leigh III, Chair, Department of Ceramic Engineering

Major	Degrees
Ceramic Engineering	M.Engr., M.S., Ph.D.

Enrollment is open to students with baccalaureate degrees in any branch of engineering and to those with degrees in chemistry or physics who have credit for certain prescribed courses in engineering.

Students may direct their programs toward traditional ceramic product fields, or they may focus on such advanced ceramics fields as optoelectronics, ceramic fibers, ceramic matrix composites or advanced heat engine ceramics. Courses in chemistry, physics, mathematics, textiles and engineering provide background for learning the behavior of materials. Study includes research into selected material topics in ceramics, metals or polymers with the preparation of a thesis as a major part of the program.

The M.S. degree program requires a minimum of 30 hours of graduate credit, including six hours of thesis research. The Ph.D. degree program requires 18 hours of dissertation research.

- CR E 602 SOLID STATE CERAMICS**  
3 cr. (3 and 0)
- CR E 603 GLASSES**  
3 cr. (3 and 0)
- CR E 604 CERAMIC COATINGS**  
3 cr. (3 and 0)
- CR E 610 ANALYTICAL PROCESSES**  
3 cr. (2 and 3)
- CR E 614 PROCESSING OF CERAMICS**  
3 cr. (3 and 0)
- CR E 616 ELECTRONIC CERAMICS**  
3 cr. (3 and 0)
- CR E 618 PROCESS CONTROL**  
3 cr. (3 and 0)
- CR E 619 SCIENCE OF ENGINEERING MATERIALS I**  
3 cr. (3 and 0)
- CR E 620 SCIENCE OF ENGINEERING MATERIALS II**  
3 cr. (3 and 0)
- CR E 630 FINE PARTICLE PROCESSING IN CERAMIC SYSTEMS**  
3 cr. (3 and 0)



- CR E 680 RESEARCH PRINCIPLES**  
1 cr. (1 and 0)
- CR E 690 SPECIAL TOPICS IN CERAMIC ENGINEERING**  
1-3 cr. (1-3 and 0)
- CR E 701 SPECIAL PROBLEMS**  
1-3 cr. (1-3 and 0)  
Practical problems in ceramic engineering analysis or design; students are assigned individual problems with topics varying from year to year in keeping with developments, interests and experience of students and instructor. May be repeated for additional credit.
- CR E 800 CERAMIC ENGINEERING SEMINAR**  
1 cr. (1 and 0)  
Discussions and presentations of current topics of ceramic science and engineering by students, faculty members and guest speakers. Required of all graduate students. Graded on a pass/fail basis.
- CR E 807 SPECIALIZED CERAMICS**  
3 cr. (3 and 0)  
Advanced study of one of the following: structural products, refractories, whitewares, abrasives, enamels, glass, cements or raw materials processing.
- CR E 809 HIGH-TEMPERATURE MATERIALS**  
3 cr. (3 and 0)  
Properties of oxides, carbides, nitrides, borides and silicides; obtainment and measurement of high temperatures; measurement of properties at high temperatures.
- CR E 814 CERAMIC PHYSICAL PROCESSING**  
3 cr. (3 and 0)  
Role of physical processing in determining structure and composition of products.
- CR E 815 COLLOIDAL AND SURFACE SCIENCE**  
3 cr. (3 and 0)  
Theory and application of colloidal and surface chemistry to ceramic materials and processes.
- CR E 816 CONSTITUTION AND STRUCTURE OF GLASSES**  
3 cr. (3 and 0)  
Modern concepts of glass structure and properties.
- CR E 821 ANALYTICAL PROCEDURES AND EQUIPMENT I**  
3 cr. (2 and 3)  
Theory and application of powder X-ray diffractometry, emission spectroscopy, electron microscopy and optical microscopy to ceramic problems.
- CR E 822 ANALYTICAL PROCEDURES AND EQUIPMENT II**  
3 cr. (2 and 3)  
Continuation of CR E 821.

- CR E 824 MECHANICAL PROPERTIES OF CERAMIC MATERIALS**  
3 cr. (3 and 0)  
Stress-strain-time relations in elasticity, plasticity and rupture showing effects of high and low temperature and structures.
- CR E 825 MAGNETIC AND ELECTRICAL CERAMIC MATERIALS**  
3 cr. (3 and 0)  
Application of magnetic and electrical theory to ceramic insulators, semiconductors, and ferroelectric and ferromagnetic products.
- CR E 828 SOLID STATE CERAMIC SCIENCE**  
3 cr. (3 and 0)  
Bonding and structure of crystalline materials as related to mechanical, thermal and chemical properties of solids.
- CR E 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- CR E 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

### Chemical Engineering

Charles H. Gooding, Chair, Department of Chemical Engineering

Major	Degrees
Chemical Engineering	M.Engr., M.S., Ph.D.

Students may be accepted with backgrounds in chemistry, physics or branches of engineering other than chemical engineering. Special programs will be planned for non-chemical-engineering graduates. Candidates for the M.S. degree must complete a thesis.

The M.Engr. degree is granted upon completion of an approved program of study which includes 30 credit hours of course work, including the core courses listed for the M.S. degree.

The M.S. degree program consists of 30 credit hours of work, including six credit hours of research. The course work includes CH E 803, 804, 805 and 823. In addition, six hours of approved chemical engineering electives and six hours of approved technical electives are required.

The Ph.D. program consists of 36 credit hours of approved graduate courses beyond the B.S. degree, including 12 credit hours of approved graduate courses at Clemson University. Doctoral students must satisfy the M.S. course requirements through courses taken either at Clemson University or elsewhere. Each doctoral student must complete credit hours of approved graduate courses offered by departments other than chemical engineering. In addition, each student is required to complete 30 credit hours of graduate research, including 18 doctoral dissertation research credit hours (CH E 991) taken at Clemson University. These requirements establish **minimum** course work and research credit requirements and usually are exceeded at the advice of the individual student's advisory committee.

Minors for doctoral students may be taken in chemistry, physics, mathematics, life sciences or other branches of engineering.

- CH E 601 TRANSPORT PHENOMENA**  
3 cr. (3 and 0)
- CH E 612 POLYMER ENGINEERING**  
3 cr. (3 and 0)
- CH E 628 BIOCHEMICAL ENGINEERING**  
(AG E 628) 3 cr. (3 and 0)



- CH E 650**      **CHEMICAL REACTION ENGINEERING**  
3 cr. (3 and 0)
- CH E 654**      **COMPUTER PROCESS CONTROL**  
3 cr. (3 and 0)
- CH E 802**      **PROCESS DYNAMICS AND CONTROL**  
3 cr. (3 and 0)  
Utilization of engineering principles in dynamic analysis and design of chemical processes, processing equipment and plants; systems dynamics; closed loop control and optimization. **Prerequisites:** CH E 353 and MTHSC 208 or permission of instructor.
- CH E 803**      **ADVANCED TRANSPORT PHENOMENA**  
3 cr. (3 and 0)  
Analysis of heat, mass and momentum transfer; derivation and application of the governing equations; solution of steady and unsteady-state multidimensional problems in fluid flow, heat transfer and mass transfer.
- CH E 804**      **CHEMICAL ENGINEERING THERMODYNAMICS**  
3 cr. (3 and 0)  
Equilibria of physical and chemical systems; generalized properties of hydrocarbons; application of thermodynamic methods in equipment design.
- CH E 805**      **CHEMICAL ENGINEERING KINETICS**  
3 cr. (3 and 0)  
Kinetics of chemical reactions, particularly in design and operation of chemical reactors.
- CH E 814**      **APPLIED NUMERICAL METHODS IN PROCESS SIMULATION**  
3 cr. (3 and 0)  
Numerical solution techniques as applied to chemical process systems; finite difference techniques for partial differential equations stressing applied numerical methods rather than theoretical numerical analysis; standard methods for ordinary differential equations reviewed. **Prerequisite:** Permission of instructor.
- CH E 818**      **POLYMER PROCESSING**  
3 cr. (3 and 0)  
Processing of polymeric materials; polymer flow characterization; extrusion; mixing; filtration; injection molding; fiber and film formation; physical science principles such as fluid flow, heat transfer, crystallization and rheology applied to polymer processing operations.
- CH E 819**      **VISCOELASTIC PROPERTIES OF POLYMERS AND POLYMERIC COMPOSITES**  
3 cr. (3 and 0)  
Time- and frequency-dependent behavior of structural polymers and their composites; interrelationship between various viscoelastic properties; influence of aging; prediction of composite viscoelastic response by application of the Viscoelastic Correspondence Principle. **Prerequisite:** Permission of instructor.
- CH E 820**      **COMPOSITE POLYMERIC MATERIALS**  
(T C 820) 3 cr. (3 and 0) N  
Morphology, chemistry, processing and physi-

cal characterization of engineered fibers and matrix materials; influence of fiber and matrix properties on composite characteristics; application of surface chemistry to analyze fiber/matrix wetting and adhesion. **Prerequisite:** CH 224 or permission of instructor.

- CH E 823**      **MASS TRANSFER AND STAGewise CONTACT OPERATIONS**  
3 cr. (3 and 0)  
Stagewise contact operations emphasizing distillation; vapor-liquid equilibria; integral and differential distillation; binary and multicomponent rectification; analytical methods; batch rectification; azeotropic and extractive distillation.
- CH E 829**      **MEMBRANE SEPARATION PROCESSES**  
3 cr. (3 and 0)  
Fundamental principles, mathematical modeling and applications of microfiltration, ultrafiltration, reverse osmosis, gas permeation and pervaporation; introduction to other membrane processes, including dialysis, Donnan dialysis, electrodialysis, liquid membranes, facilitated transport, membrane reactor and controlled release technology. **Prerequisite:** CH E 401 or equivalent or permission of instructor.
- CH E 834**      **ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS**  
3 cr. (3 and 0)  
Classical and statistical thermodynamics applied to problems in chemical engineering with emphasis on modern methods of predicting thermophysical properties of gases and liquids; students' and instructor's interests influence course content, but usually include fundamentals of applied statistical mechanics, molecular theory of dense fluids, descriptions of intermolecular forces, gas-liquid and liquid-liquid critical phenomena, theories of interfacial phenomena and adsorption, statistical mechanics of polymeric systems, statistical mechanics of polydispersed systems, computer simulation of fluids by Monte Carlo, molecular dynamics and stochastic dynamics methods. **Prerequisite:** CH E 804 or equivalent.
- CH E 845**      **SELECTED TOPICS IN CHEMICAL ENGINEERING**  
3 cr. (3 and 0)  
Topics not covered in other courses, emphasizing current literature and results of current research. Topics vary from year to year to keep pace with developments. May be repeated for credit.
- CH E 890**      **SPECIAL PROJECTS**  
1-6 cr.  
Comprehensive analytical and/or experimental treatment of phenomena of current interest in chemical engineering, emphasizing modern technological problems. May be repeated for maximum of six credits. Graded on a pass/fail basis. **Prerequisites:** Permission of instructor and department chair.
- CH E 891**      **MASTER'S THESIS RESEARCH**  
Credit to be arranged.



**CH E 895 CHEMICAL ENGINEERING GRADUATE SEMINAR**  
1 cr. (1 and 0)  
Series of weekly, one-hour seminars given by students, faculty and guests on topics of current interest. Graded on a pass/fail basis. Credits earned in this course do not apply to nor alter the required minimum of six research hours for the M.S. degree or the required 30 research credit hours for the Ph.D. degree.

**CH E 945 SELECTED TOPICS IN CHEMICAL ENGINEERING**  
3 cr. (3 and 0)  
Primarily a more comprehensive study of topics first covered in CH E 845.

**CH E 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

## Materials Science and Engineering

R. Judd Diefendorf, Program Coordinator, Department of Ceramic Engineering

<b>Major</b>	<b>Degrees</b>
Materials Science and Engineering	M.S., Ph.D.

Materials science and engineering is concerned with the production, properties and microstructure of the solid materials which are often the primary limitation to the advancement of modern technology. Emphasis is placed on applying the fundamental principles that govern the structure of the solid state to produce optimum mechanical, electrical, optical and other physical properties.

Students with a baccalaureate degree in any branch of engineering, as well as chemistry, physics and biology majors with a strong mathematical background, may be admitted to the program. The curriculum provides for specialization in metallurgy, glasses and ceramics, electronic materials, biomaterials, polymer and fiber science, and composite materials. The program is designed to produce engineers and scientists whose degrees represent specialization coupled with a broad foundation in all materials.

Master's degree candidates must complete 24 credits of course work and six credits of research. Three credits each are required in the areas of thermodynamics and kinetics, and two of four courses in electronic materials, deformation mechanisms in solids or polymer science must be taken.

The Doctor of Philosophy degree is aimed at providing the student with a comprehensive foundation in materials science and engineering. The major field of study is generally interdisciplinary in nature, consisting of course work in several areas of engineering and science. A minimum of 45 credits of course work is required. Qualifying, comprehensive and final examinations are required. No foreign language is required, but proficiency in one is recommended.

Candidates for the master's and doctoral degrees are affiliated with the department in which their research professor holds faculty position.

**MAT E 800 SEMINAR IN MATERIALS RESEARCH**  
1 cr. (1 and 0)  
Presentation and discussion of special topics and original research in materials engineering. Credit may be earned for more than one semester.

**MAT E 820 DEFORMATION MECHANISMS IN SOLIDS**  
3 cr. (3 and 0)  
Dislocation theory of solids; mechanisms of plastic deformation in single crystals and

polycrystalline aggregates of metals and non-metals; ductile and brittle fractures; fatigue, creep and stress corrosion cracking of metals.  
**Prerequisite:** Permission of instructor.

**MAT E 826 PHASE EQUILIBRIA IN MATERIALS SYSTEMS**  
3 cr. (3 and 0)  
Advanced treatment of phase equilibria in materials systems, phase diagrams, thermodynamics of defects, surfaces, interfaces and solutions. **Prerequisites:** CR E 310 and permission of instructor. **Corequisite:** M E 810.

**MAT E 827 KINETICS OF PHASE TRANSFORMATION**  
3 cr. (3 and 0)  
Advanced treatment of the kinetics of phase transformation in materials systems, including nucleation, growth and spinodal decomposition. **Prerequisites:** MAT E 826 or equivalent, graduate standing and permission of instructor.

**MAT E 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

*The following courses offered by various departments complete the curriculum for the program. Descriptions for all 800-level courses are under the respective departmental headings.*

**BIO E 801 BIOMATERIALS**  
3 cr. (3 and 0)

**BIO E 803 POLYMERIC BIOMATERIALS**  
3 cr. (3 and 0)

**BIO E 805 COMPOSITE BIOMATERIALS**  
3 cr. (3 and 0)

**BIO E 850 SPECIAL TOPICS IN BIOMEDICAL ENGINEERING**  
1-4 cr. (0-4 and 12-0)

**CR E 807 SPECIALIZED CERAMICS**  
3 cr. (3 and 0)

**CR E 809 HIGH-TEMPERATURE MATERIALS**  
3 cr. (3 and 0)

**CR E 814 CERAMIC PHYSICAL PROCESSING**  
3 cr. (3 and 0)

**CR E 815 COLLOIDAL AND SURFACE SCIENCE**  
3 cr. (3 and 0)

**CR E 816 CONSTITUTION AND STRUCTURE OF GLASSES**  
3 cr. (3 and 0)

**CR E 821 ANALYTICAL PROCEDURES AND EQUIPMENT I**  
3 cr. (2 and 3)

**CR E 822 ANALYTICAL PROCEDURES AND EQUIPMENT II**  
3 cr. (2 and 3)

**CR E 824 MECHANICAL PROPERTIES OF CERAMIC MATERIALS**  
3 cr. (3 and 0)



<b>CR E 825</b>	<b>MAGNETIC AND ELECTRICAL CERAMIC MATERIALS</b> 3 cr. (3 and 0)
<b>CR E 828</b>	<b>SOLID STATE CERAMIC SCIENCE</b> 3 cr. (3 and 0)
<b>CH E 601</b>	<b>TRANSPORT PHENOMENA</b> 3 cr. (3 and 0)
<b>CH E 612</b>	<b>POLYMER ENGINEERING</b> 3 cr. (3 and 0)
<b>CH E 803</b>	<b>ADVANCED TRANSPORT PHENOMENA</b> 3 cr. (3 and 0)
<b>CH E 818</b>	<b>POLYMER PROCESSING</b> 3 cr. (3 and 0)
<b>CH E 819</b>	<b>VISCOELASTIC PROPERTIES OF POLYMERS AND POLYMERIC COMPOSITES</b> 3 cr. (3 and 0)
<b>CH E 820</b> (T C 820)	<b>COMPOSITE POLYMERIC MATERIALS</b> 3 cr. (3 and 0) N
<b>CH 602</b>	<b>INORGANIC CHEMISTRY</b> 3 cr. (3 and 0) F
<b>CH 804</b>	<b>FUNDAMENTAL PRINCIPLES OF INORGANIC CHEMISTRY</b> 3 cr. (3 and 0) F
<b>CH 809</b>	<b>CHEMICAL APPLICATIONS OF X-RAY CRYSTALLOGRAPHY</b> 3 cr. (2 and 2) S (odd numbered years)
<b>CH 811</b>	<b>ANALYTICAL CHEMISTRY</b> 3 cr. (3 and 0) F
<b>CH 812</b>	<b>CHEMICAL SPECTROSCOPIC METHODS</b> 3 cr. (2 and 3) S
<b>CH 910</b>	<b>SELECTED TOPICS IN ANALYTICAL CHEMISTRY</b> 1-4 cr. (1-4 and 0) N
<b>E M 630</b>	<b>MECHANICS OF COMPOSITE MATERIAL</b> 3 cr. (3 and 0)
<b>E M 831</b>	<b>THEORY OF ELASTICITY I</b> 3 cr. (3 and 0)
<b>E M 832</b>	<b>THEORY OF ELASTICITY II</b> 3 cr. (3 and 0)
<b>E M 836</b>	<b>FRACTURE MECHANICS</b> 3 cr. (3 and 0)
<b>E M 852</b> (C E 852)	<b>ADVANCED FINITE ELEMENT ANALYSIS</b> 3 cr. (3 and 0)
<b>M E 801</b>	<b>FOUNDATIONS OF FLUID MECHANICS</b> 3 cr. (3 and 0)
<b>M E 810</b>	<b>MACROSCOPIC THERMODYNAMICS</b> 3 cr. (3 and 0)

<b>M E 815</b> (PHYS 815)	<b>STATISTICAL THERMODYNAMICS I</b> 3 cr. (3 and 0)
<b>M E 818</b>	<b>INTRODUCTION TO FINITE ELEMENT ANALYSIS</b> 3 cr. (3 and 0)
<b>M E 932</b>	<b>ADVANCED TOPICS IN THERMODYNAMICS</b> 3 cr. (3 and 0)
<b>PHYS 811</b>	<b>METHODS OF THEORETICAL PHYSICS I</b> 3 cr. (3 and 0)
<b>PHYS 812</b>	<b>METHODS OF THEORETICAL PHYSICS II</b> 3 cr. (3 and 0)
<b>PHYS 816</b>	<b>STATISTICAL THERMODYNAMICS II</b> 3 cr. (3 and 0)
<b>PHYS 845</b>	<b>SOLID STATE PHYSICS I</b> 3 cr. (3 and 0)
<b>PHYS 846</b>	<b>SOLID STATE PHYSICS II</b> 3 cr. (3 and 0)
<b>T C 615</b>	<b>INTRODUCTION TO POLYMER SCIENCE AND ENGINEERING</b> 3 cr. (3 and 0) F
<b>T C 811</b>	<b>POLYMER SCIENCE I</b> 3 cr. (3 and 0) F
<b>T C 812</b>	<b>POLYMER SCIENCE II</b> 3 cr. (3 and 0) S
<b>TEXT 821</b>	<b>FIBER PHYSICS I</b> 3 cr. (3 and 0) F
<b>TEXT 822</b>	<b>FIBER PHYSICS II</b> 3 cr. (3 and 0) S
<b>TEXT 830</b>	<b>TEXTILE PHYSICS</b> 3 cr. (3 and 0) F
<b>TEXT 835</b>	<b>TEXTILE STRUCTURES I</b> 3 cr. (3 and 0) F
<b>TEXT 846</b>	<b>TEXTILE STRUCTURES II</b> 3 cr. (3 and 0) S
<b>TEXT 866</b>	<b>FIBER FORMATION</b> 3 cr. (3 and 0) S

### *School of the Environment*

Glen T. Daigger, Director

### **Environmental Science and Policy**

Alan W. Elzerman, Program Director, Department of Environmental Systems Engineering

Advanced degrees are not awarded in environmental science and policy, but courses are offered to provide a minor, a concentration or electives for students in other areas. Course selection for a minor or concentration should be approved in advance. Scientific and engineering courses are offered as well as relevant courses in economics, history, ethics, public health, political science and other related areas.



**EN SP 631 PUBLIC HEALTH ADMINISTRATION**  
3 cr. (3 and 0) N

**EN SP 671 MAN AND HIS ENVIRONMENT**  
2 cr. (2 and 0) N

**EN SP 672 ENVIRONMENTAL PLANNING AND CONTROL**  
2 cr. (2 and 0) N

### Environmental Systems Engineering

Glen T. Daigger, Chair, Department of Environmental Systems Engineering

#### Major

Environmental Systems  
Engineering

#### Degrees

M.Engr., M.S., Ph.D.

Environmental systems engineering is concerned with the engineering aspects of the control of the environment. Emphasis is placed on applying fundamental principles of the basic and engineering sciences through research and design to environmental engineering problems.

The M.Engr. program is designed to build on an ABET-accredited engineering baccalaureate background, while the M.S. degree builds on a student's previous engineering or science background. Students with a baccalaureate degree in any branch of engineering, as well as chemistry, physics, geology and biology majors with a strong mathematical background, may be admitted to the program. Students usually elect to specialize in one of seven areas: (1) process engineering, (2) hazardous and radioactive waste treatment, (3) contaminant characterization, (4) contaminant fate and transport, (5) analysis of natural systems, (6) environmental restoration, and (7) risk assessment and waste management. Research master's degree candidates must complete 24 hours of course work and six hours of research culminating in the presentation of a satisfactory thesis for M.S. candidates or a special problem report for M.Engr. candidates. An M.S. nonthesis option which requires 33 hours of course work is available.

The Ph.D. program is directed toward providing the student with a comprehensive background in the fundamental aspects of environmental engineering. The major field of study is generally interdisciplinary in nature, consisting of course work in several areas of engineering and the basic sciences. Each student's research program is tailored to suit his or her personal and professional goals. Qualifying, comprehensive and final examinations are required. No foreign language is required.

**E S E 601 ENVIRONMENTAL ENGINEERING**  
3 cr. (3 and 0) F, S

**E S E 602 WATER AND WASTE TREATMENT SYSTEMS**  
3 cr. (3 and 0) S

**E S E 608 LAND TREATMENT OF WASTEWATER AND SLUDGES**  
(AG E 608)  
(AGRON 608) 3 cr. (3 and 0) F

**E S E 610 ENVIRONMENTAL RADIATION PROTECTION**  
3 cr. (3 and 0) F

**E S E 611 IONIZING RADIATION DETECTION AND MEASUREMENT**  
2 cr. (1 and 3) S

**E S E 630 AIR POLLUTION ENGINEERING**  
3 cr. (3 and 0) S

**E S E 651 NEWMAN SEMINAR AND LECTURE SERIES IN NATURAL RESOURCES ENGINEERING**  
(AG E 651)  
(FOR 651) 1 cr. (0 and 2) S, F

**E S E 682 GROUNDWATER AND CONTAMINANT TRANSPORT**  
(C E 682) 3 cr. (3 and 0) S

**E S E 684 MUNICIPAL SOLID WASTE MANAGEMENT**  
(AG E 684)  
(I E 684) 3 cr. (3 and 0) S

**E S E 685 HAZARDOUS WASTE MANAGEMENT**  
3 cr. (3 and 0) S

**E S E 701 SPECIAL PROBLEMS**  
1-6 cr. (1-6 and 0) F, S  
Environmental engineering problems selected to meet the interests and experience of student and instructor; formal report required. Restricted to Master of Engineering students. Graded on a pass/fail basis.

**E S E 802 ENVIRONMENTAL ENGINEERING PRINCIPLES**  
3 cr. (3 and 0) F  
Fundamental principles required for simulation and modeling of environmental engineering phenomena. Topics include mass transfer, reactor kinetics, simulation techniques and applications to various natural and engineered systems.

**E S E 803 PHYSICOCHEMICAL OPERATIONS IN WATER AND WASTEWATER TREATMENT SYSTEMS**  
4 cr. (4 and 0) S  
Principles of physicochemical operations used in water and wastewater treatment, including sedimentation, filtration, mixing, gas transfer, adsorption, ion exchange, coagulation, precipitation, disinfection and oxidation. **Prerequisites:** E S E 802 and 843.

**E S E 804 BIOCHEMICAL OPERATIONS IN WASTEWATER TREATMENT SYSTEMS**  
3 cr. (3 and 0) S  
Principles of biochemical operations used in wastewater treatment; includes modeling of ideal biochemical reactors and design criteria for aerated lagoons, activated sludge, trickling filters, rotating biological contactors, nitrification, denitrification and digestion. **Prerequisites:** E S E 802 and E S E 851.

**E S E 805 LABORATORY IN WATER AND WASTEWATER TREATMENT OPERATIONS**  
2 cr. (0 and 6) S  
Laboratory exercises in selected water and wastewater treatment operations, including sedimentation, filtration, adsorption, coagulation, softening, aeration, activated sludge, aerobic digestion and anaerobic digestion. **Corequisites:** E S E 803 and 804.



- E S E 806**      **INTEGRATED DESIGN OF WATER AND WASTEWATER TREATMENT SYSTEMS**  
4 cr. (4 and 0) F  
Integration of unit operations into complex systems for treatment of industrial/domestic water and wastewater, contaminated groundwater, landfill leachate and toxic liquid wastes; the team approach is employed in the design of one integrated system for either water/wastewater or a hazardous/toxic waste. **Prerequisites:** E S E 803 and 804.
- E S E 809**      **INDUSTRIAL WASTEWATER TREATMENT**  
3 cr. (3 and 0) N  
Industrial wastewater management and the application of liquid treatment processes to the solution of specific industrial wastewater problems; case studies of industrial wastewater treatment strategies. **Prerequisites:** E S E 803 and 804.
- E S E 812**      **ENVIRONMENTAL NUCLEAR ENGINEERING**  
3 cr. (3 and 0) S  
Environmental aspects of nuclear technology emphasizing nuclear reactors and the nuclear fuel cycle; environmental transport of radioactive materials; radioactive effluents from nuclear power plants; nuclear power plant safety; environmental aspects of fuel cycle activities; waste management. **Prerequisites:** E S E 610 and permission of instructor.
- E S E 813**      **ENVIRONMENTAL RADIATION PROTECTION LABORATORY**  
1 cr. (0 and 3) F  
Continuation of E S E 611; advanced experiments in radiation detection, radiation protection, health physics and environmental monitoring. **Prerequisites:** E S E 611 and permission of instructor.
- E S E 832**      **AIR POLLUTION METEOROLOGY**  
3 cr. (3 and 0) F  
Applications of meteorology to air pollution; micrometeorology; plume rise modeling; atmospheric diffusion; deposition and washout of pollutants; air chemistry; applications of diffusion modeling to air quality planning. **Prerequisite:** Permission of instructor.
- E S E 833**      **AIR POLLUTION CONTROL SYSTEMS**  
3 cr. (3 and 0) F  
Principles and design of air pollution control equipment including mechanical collectors, electrostatic precipitators, baghouse filters, wet scrubbers, adsorbers and incinerators. **Prerequisite:** E S E 430/630 or permission of instructor.
- E S E 843**      **ENVIRONMENTAL ENGINEERING CHEMISTRY I**  
3 cr. (3 and 0) F  
Principles of chemical kinetics and thermodynamics applied to fundamental understanding of aqueous environmental samples including natural waters, wastewaters and treated waters; factors controlling chemical concentrations, acid-base equilibria, solubility equilibria, complex formation, electrochemistry, adsorption phenomena. **Prerequisites:** CH 101 and 102 or equivalent.
- E S E 844**      **ENVIRONMENTAL ENGINEERING CHEMISTRY LABORATORY I**  
3 cr. (2 and 3) F  
Laboratory experience in basic analytical methods used in water quality studies; experimental design, sampling, wet-chemical analytical techniques, data collection and analysis, data interpretation, and data quality techniques. **Prerequisites:** Two semesters of general chemistry.
- ESE 845**      **ENVIRONMENTAL ENGINEERING CHEMISTRY II**  
3 cr. (3 and 0)  
Application of parameters that describe the equilibrium distribution and exchange rates for environmentally significant organic compounds to the modeling of processes in engineered and natural systems, including environmental parameter estimation techniques, structure-activity relationships, and integration of environmental processes to model contaminant distribution and residence time in environmental systems. **Prerequisites:** Two semesters of general chemistry and ESE 843 or equivalent.
- E S E 847**      **ADVANCED TOPICS IN ENVIRONMENTAL ENGINEERING CHEMISTRY**  
3 cr. (3 and 0) S  
Advanced principles and methods in environmental engineering chemistry with applications to both natural and treatment systems; current investigative and study techniques. Topics include the nature, fluxes and controlling processes of chemical species and radionuclides in environmental systems. **Prerequisite:** E S E 843 or equivalent.
- E S E 849**      **ENVIRONMENTAL ENGINEERING CHEMISTRY LABORATORY II**  
2 cr. (0 and 6) N  
Theory and applications of instrumental methods of analysis as applied to measurements for environmental control; spectroscopy and spectrophotometric techniques; electrochemical analyses; chromatographic methods of analysis; light scattering and electrophoretic measurements.
- E S E 850**      **STREAM AND ESTUARINE ANALYSIS**  
3 cr. (3 and 0) F  
Physical, chemical and biological processes and relationships which exist in streams and estuaries; estuarine environment; free-flowing streams; mechanisms describing transport of conservative and nonconservative materials through estuarine systems; the estuary as a resource and techniques for its management.
- E S E 851**      **BIOLOGICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING**  
3 cr. (3 and 0) F  
Basic principles of biology and biochemistry as applied to problems of environmental control and wastewater treatment; kinetic and energetic aspects are emphasized.



- E S E 856 POLLUTION OF THE AQUATIC ENVIRONMENT**  
3 cr. (3 and 0) S  
Effects of domestic and industrial water pollution on the physical, chemical and biological characteristics of natural waters; associated environmental determinants of human disease, toxicology and epidemiology of chronic disease.
- E S E 857 POLLUTION OF THE AQUATIC ENVIRONMENT LABORATORY**  
1 cr. (0 and 3) N  
Field and laboratory investigations into physical, chemical and biological effects resulting from pollution of the aquatic environment.
- E S E 861 ENVIRONMENTAL SYSTEMS ENGINEERING SEMINAR**  
1 cr. (1 and 0) F, S  
Current advances and research developments in various areas of environmental engineering; off-campus speakers, students and faculty participate. Graded on a pass/fail basis.
- E S E 862 ENVIRONMENTAL QUALITY CASE STUDY**  
1 cr. (0 and 3) N  
Analysis and investigation of a significant current or recent situation affecting or involving some facet of environmental quality. Study is conducted by a team of students and results in a comprehensive position paper which integrates the pertinent social, political and economic considerations in the case with the technical aspects.
- E S E 880 ENVIRONMENTAL RISK ASSESSMENT**  
3 cr. (3 and 0) S  
Methodology of quantitative risk assessment, including identification and quantification of the source term, calculation of environmental transport and estimation of health effects; applications involve various classes of contaminants in atmospheric and aquatic environmental pathways. **Prerequisites:** MTHSC 208 and graduate-level standing in engineering or science.
- E S E 881 SPECIAL PROBLEMS**  
1-4 cr. F, S  
Problems selected to meet interests and experience of student and instructor.
- E S E 883 SELECTED TOPICS IN ENVIRONMENTAL ENGINEERING**  
1-4 cr. F, S  
A topic in environmental engineering not covered in another course. Topic varies to keep pace with current developments. May be taken concurrently with E S E 884, which (if offered) would be a different topic.
- E S E 884 SELECTED TOPICS IN ENVIRONMENTAL ENGINEERING**  
1-4 cr. F, S  
A topic in environmental engineering not covered in another course. Topic varies to keep pace with current developments. May be taken concurrently with E S E 883, which (if offered) would be a different topic.

**E S E 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged. F, S

**E S E 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged. F, S

### Environmental Toxicology

Stephen J. Klaine, Chair, Department of Environmental Toxicology

<b>Major</b>	<b>Degrees</b>
Environmental Toxicology	M.S., Ph.D.

See the College of Agriculture, Forestry and Life Sciences for information on this program.

### Hydrogeology

Richard D. Warner, Chair, Department of Geological Sciences

<b>Major</b>	<b>Degree</b>
Hydrogeology	M.S.

Candidates for the Master of Science degree in hydrogeology should have a baccalaureate degree in the geosciences. However, students having a strong undergraduate background in chemistry, physics or biology, or in civil, environmental or agricultural engineering may be admitted but will be required to correct deficiencies in their geologic education during the first year. Specifically, GEOL 302 (Structural Geology), GEOL 306 (Mineralogy) and a course in petrology or stratigraphy are required. Credit toward the M.S. degree will not be allowed for 400/600-level courses listed in the *Clemson University Undergraduate Announcements* as required courses for the B.S. or B.A. degrees in geology.

Two options are offered for the M.S. degree. The nonthesis option requires 30 semester hours of course work and a final written examination. The thesis option requires 24 semester hours of course work and six hours of thesis research. Candidates must write a thesis based on original research and defend it at an oral examination.

All candidates must take at least six of the following core courses: E S E/C E 682, E S E 685, GEOL 608, 612, 800, 804, 805, 808, 809, 810 and 875. Three of these must be 800-level geology courses. Students may also select a number of recommended elective courses in engineering and geology from an approved list available in the department.

- |                 |   |
|-----------------|---|
| <b>GEOL 600</b> | <b>ENVIRONMENTAL GEOLOGY</b><br>3 cr. (3 and 0)             |
| <b>GEOL 601</b> | <b>APPLIED GEOPHYSICS</b><br>3 cr. (2 and 2)                |
| <b>GEOL 603</b> | <b>INVERTEBRATE PALEONTOLOGY</b><br>3 cr. (2 and 3)         |
| <b>GEOL 604</b> | <b>ECONOMIC GEOLOGY</b><br>3 cr. (3 and 0)                  |
| <b>GEOL 605</b> | <b>GEOMORPHOLOGY</b><br>3 cr. (2 and 3)                     |
| <b>GEOL 607</b> | <b>QUATERNARY GEOLOGY</b><br>3 cr. (2 and 2)                |
| <b>GEOL 608</b> | <b>GEOHYDROLOGY</b><br>3 cr. (3 and 0)                      |
| <b>GEOL 612</b> | <b>GEOCHEMICAL ANALYTICAL TECHNIQUES</b><br>3 cr. (1 and 4) |



- GEOL 613 STRATIGRAPHY**  
3 cr. (2 and 2)
- GEOL 651 SELECTED TOPICS IN HYDROGEOLOGY**  
1-4 cr. (1-3 and 0-3)
- GEOL 700 GEOLOGY FOR SCIENCE TEACHERS**  
3 cr. (2 and 3)  
Geology for elementary and secondary school teachers of earth science and physical sciences; geologic methods; origin of the earth, rocks and minerals; processes and changes through time of the crust and surface; field trips provide practical examples.
- GEOL 740 EARTH/SPACE SCIENCE FOR ELEMENTARY SCHOOL TEACHERS**  
3 cr. (2 and 3)  
Comprehension and application of earth/space science concepts suitable for classroom use at the elementary school level; earth science concepts will be related to South Carolina geological features.
- GEOL 790 SELECTED TOPICS IN EARTH SCIENCES**  
1-6 cr. (0-6 and 0-18)  
A study of one or more earth science topics; lecture and laboratory emphasize the incorporation of new or updated subject matter into classroom instruction. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered.
- GEOL 800 GROUNDWATER GEOCHEMISTRY**  
3 cr. (2 and 3)  
Lectures and project-oriented field work focusing on processes controlling natural impurities in groundwater and the occurrence of inorganic, organic and radioactive contaminants. Topics include solution equilibria, chemical weathering, oxidation-reduction, utilization of radioactive isotopes as tracers and studies of contamination plumes. **Prerequisites:** CH 101 and 102 or equivalent.
- GEOL 801 GROUNDWATER GEOPHYSICAL TECHNIQUES**  
3 cr. (1 and 4)  
Lectures and project-oriented field work focusing on the utilization of geophysical instruments to detect groundwater-bearing fracture zones, to determine the depth to the water table, and to map contamination plumes. **Prerequisite:** PHYS 221 or permission of instructor.
- GEOL 804 WATER WELL EXPLORATION, DRILLING AND MONITORING**  
3 cr. (2 and 2)  
Locating sites for high yield water wells by means of satellite imagery, aerial photographs, topographic maps, subsurface and surface geological maps; drilling and coring techniques; installation of monitor wells and interpretation of data from monitor wells. **Prerequisite:** GEOL 408/608 or its equivalent.
- GEOL 805 ADVANCED STRATIGRAPHY**  
3 cr. (3 and 0)  
Classification, distribution, chronologic succession and correlation of sedimentary rocks; interpretation of features of strata in terms of their origin, depositional environment, paleogeography and relation to organic evolution; Atlantic Coastal Plain stratigraphy. **Prerequisite:** GEOL 413/613 or permission of instructor.
- GEOL 806 AQUIFER CHARACTERIZATION**  
3 cr. (3 and 0)  
Characterization of aquifers from the microscopic scale to the regional scale; geological origin of aquifers and modification by diagenetic and deformational processes; application of subsurface geological techniques to data acquisition and interpretation; prediction of fluid occurrence and flow by integrating results of subsurface analysis.
- GEOL 808 GROUNDWATER MODELING**  
4 cr. (3 and 2)  
Mathematical and computer modeling of groundwater flow and nonreactive solute transport through geological formations; conceptual flow-models for geologic systems; formulation of governing mass and energy conservation equations; application of analytical, numerical and stochastic models to real-world problems. **Prerequisite:** Permission of instructor.
- GEOL 809 SUBSURFACE REMEDIATION MODELING**  
3 cr. (3 and 0)  
Lectures and computer exercises involving subsurface remediation methods, including groundwater extraction, soil vapor extraction, steam flooding and a variety of other techniques; emphasis is on modeling flow of multiphase and multicomponent mixtures in porous medium. **Prerequisite:** GEOL 808 or permission of instructor.
- GEOL 810 ANALYTICAL METHODS FOR HYDROGEOLOGY**  
3 cr. (3 and 0)  
Analytical mathematical methods for modeling subsurface fluid flow and transport processes including saturated water flow, unsaturated zone gas flow, chemical transport and heat transfer, emphasizing the derivation and solution of governing equations for modeling subsurface flow and transport. **Prerequisite:** GEOL 808 or a graduate level groundwater course or permission of instructor.
- GEOL 850 SELECTED TOPICS IN ENVIRONMENTAL GEOLOGY**  
1-4 cr. (1-3 and 0-3)  
Selected topics in environmental geology emphasizing the subsurface contamination. May be repeated for a maximum of six credit hours, but only if different topics are covered. **Prerequisite:** Permission of instructor.
- GEOL 851 GEOLOGY SEMINAR**  
1 cr. (1 and 0)  
Students review current topics in geology and make oral presentations. May be taken twice for credit.



**GEOL 875 HYDROGEOLOGY SUMMER FIELD CAMP**  
6 cr. (4 and 6)  
Groundwater geology field techniques including examination of surface exposures, analysis of cores and geophysical well logs, subsurface mapping, aquifer performance tests and groundwater remediation. **Prerequisite:** Permission of instructor.

**GEOL 876 APPLIED HYDROGEOLOGY**  
3 cr. (3 and 0)  
Well installation methods and techniques; describing core and constructing lithologic logs; applying lithologic and geophysical logs to delineate aquifers and aquitards by subsurface mapping; using well testing methods to determine aquifer characteristics by conducting aquifer performance tests and analyzing test data. Taught at the Savannah River Site.

**GEOL 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.

### *School of Mechanical and Industrial Engineering*

James A. Liburdy, Director

### **Engineering Graphics**

William F. Beckwith, Program Director, Freshman Engineering and Engineering Graphics

Advanced degrees are not awarded in engineering graphics. Courses are offered as electives for students in engineering and other areas.

**E G 612 INTERACTIVE COMPUTER GRAPHICS**  
3 cr. (3 and 0)

**E G 690 SPECIAL TOPICS IN ENGINEERING AND COMPUTER GRAPHICS**  
1-3 cr.

**E G 823 COMPUTER-AIDED GEOMETRIC MODELING**  
3 cr. (3 and 0)  
Shape modeling and design by computer; curve and surface representation, methods of solid modeling by computer; data base representation and integral properties of solid models. **Prerequisite:** Graduate standing.

### **Engineering Mechanics**

Richard S. Figliola, Chair, Department of Mechanical Engineering

<b>Major</b>	<b>Degrees</b>
Engineering Mechanics	M.S., Ph.D.

Enrollment is open to students with baccalaureate or master's degrees in any branch of engineering and to those with degrees in physics or applied mathematics who have credit for certain prescribed courses in engineering.

General areas of concentration are solid mechanics, composite materials, numerical methods and dynamics. Some limitations are imposed on the selection of courses to reflect the particular concentration. The usual minor is mathematics. Suitable minor programs also may be arranged in physics, civil engineering or mechanical engineering.

Candidates for the M.S. degree are required to write a thesis and complete 30 hours of course work, including six hours of the-

sis research. Candidates for the Ph.D. degree are required to complete 18 hours of dissertation research.

**E M 625 ADVANCED STRENGTH OF MATERIALS**  
3 cr. (3 and 0)

**E M 630 MECHANICS OF COMPOSITE MATERIALS**  
3 cr. (3 and 0)

**E M 650 MECHANICAL VIBRATIONS**  
3 cr. (3 and 0)

**E M 829 ENERGY METHODS AND VARIATIONAL PRINCIPLES**  
3 cr. (3 and 0)  
Application of variational principles in solid mechanics problems; virtual work; Castigliano's theorems on deflection and rotation; stationary potential energy; energy stability criterion; Hamilton's principle. **Prerequisite:** E M 831 or permission of instructor.

**E M 831 THEORY OF ELASTICITY I**  
3 cr. (3 and 0)  
Theory of stress and deformation for continuous media; linear stress-strain relations for elastic material; two-dimensional problems, including Airy stress function, polynomial solutions, plane stress and plane strain in rectangular and polar coordinates, torsion and bending of prismatic bars and thermal stresses. **Prerequisites:** E M 304 and MTHSC 208.

**E M 832 THEORY OF ELASTICITY II**  
3 cr. (3 and 0)  
Continuation of E M 831, including topics from either three-dimensional problems associated with an infinite elastic medium, elastic half-space, contact stresses, symmetrically loaded sphere and circular cylinder, or complex variable methods in plane elasticity, stress concentrations problems, singular stresses and fracture, and composite materials. **Prerequisites:** E M 831 and PHYS 812.

**E M 834 PRINCIPLES OF STRUCTURAL STABILITY**  
3 cr. (3 and 0)  
Practical criteria for analysis of conservative and nonconservative systems' stability; methods of adjacent equilibrium, initial imperfections, total potential energy and vibration as applied to practical problems. **Prerequisite:** E M 831.

**E M 836 FRACTURE MECHANICS**  
3 cr. (3 and 0)  
Fundamental elasticity-based course in the development of the basic concepts of engineering fracture mechanics; the Griffith criterion, Barrenblatt and Dugdale models, linear elastic fracture mechanics (L.E.F.M.), plane strain fracture toughness, the crack-tip stress and strain field, and plasticity and the J-integral. **Prerequisite:** E M 831.



- E M 845 INTERMEDIATE DYNAMICS**  
3 cr. (3 and 0)  
Kinematics and dynamics of particles and rigid bodies, Lagrange and Hamilton's formulation of mechanics; two-body central force problem; rendezvous of two bodies in a central force field; rotation of rigid bodies about a fixed point in space; vector analysis and matrix methods as aids in mathematical analysis. **Prerequisite:** E M 202 or permission of instructor.
- E M 852 ADVANCED FINITE ELEMENT ANALYSIS**  
(C E 852) 3 cr. (3 and 0)  
Application of variational and weighted residuals methods; nonlinear analysis, steady-state and time-dependent problems; application of commercial finite element codes; advanced computational procedures. **Prerequisite:** C E 808 or equivalent, or permission of instructor.
- E M 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- E M 893 SELECTED TOPICS IN ENGINEERING MECHANICS**  
1-6 cr. (1-6 and 0)  
Topics not covered in other courses. May be repeated for credit.
- E M 901 FOUNDATIONS OF NONLINEAR SHELL THEORY**  
3 cr. (3 and 0)  
Development of classical linear and nonlinear foundations used to analyze thin shells of arbitrary geometric shape; general equations are specialized for thin shells made from isotropic and orthotropic materials and nonhomogeneous shells such as sandwich and fiber-reinforced composite shells. **Prerequisites:** E M 829 and 831.
- E M 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

## Industrial Engineering

Delbert L. Kimbler, Chair, Department of Industrial Engineering

Major	Degrees
Industrial Engineering	M.S., Ph.D.

Industrial engineering is concerned with the design, improvement and installation of integrated systems of people, materials, equipment and information. It draws upon specialized knowledge and skill in the mathematical, physical and social sciences, together with the principles and methods of engineering analysis and design, to specify, predict and evaluate the results obtained from such systems.

The focus of the graduate program is on quality engineering. In general, students concentrate their studies in one of four areas: human factors engineering, manufacturing systems, operations research and quality engineering. They choose supporting course work from within the department and from other departments. Areas of research interest among the faculty include applied optimization, computer-integrated manufacturing, design methodology, engineering economic analysis, facility planning and material handling, health care and information systems design, human-computer interaction, human-machine systems engineering, industrial ergonomics, maintenance systems design, manufacturing systems engineering, production planning and control, quality en-

gineering, solid and hazardous waste management, and systems modeling and simulation. A variety of laboratory facilities are available within the department to support research in these areas.

Students with a bachelor's degree in engineering or the physical sciences may be accepted. Those with other backgrounds may be accepted or may be required to complete successfully certain prerequisite courses before acceptance into the program. Entering graduate students are assumed to have competency in the following areas: mathematics, including calculus, linear algebra, differential equations, probability and statistics; calculus-based physics and computer programming. A student with deficiencies in these areas is required to take additional undergraduate course work as a condition of admission to the graduate program. No graduate credit is given for such courses.

Students may pursue an M.S. degree with a thesis, requiring a minimum of 24 graduate credit hours of course work, six credit hours of master's thesis research and one credit hour of seminar. Alternatively, students may pursue an M.S. degree without a thesis, requiring a minimum of 30 graduate credit hours of course work, three credit hours of project work and one credit hour of seminar. The prescribed credit hours of course work are agreed upon by the student and his or her advisory committee and are in addition to any needed to compensate for undergraduate deficiencies.

Work leading to the Ph.D. degree is planned to give the student a comprehensive knowledge of the field of industrial engineering and a mastery of the methods of research. The advisory committee aids the student in developing a doctoral degree curriculum. A minimum requirement of 48 semester credit hours of graduate course work exists for the doctoral degree. A dissertation is mandatory for all Ph.D. candidates and requires 18 credit hours of doctoral research.

- I E 601 WORK METHODS AND MEASUREMENT II**  
3 cr. (2 and 3)
- I E 622 EXPERT SYSTEMS**  
3 cr. (3 and 0)
- I E 652 RELIABILITY ENGINEERING**  
3 cr. (3 and 0)
- I E 660 QUALITY IMPROVEMENT METHODS**  
3 cr. (3 and 0)
- I E 661 QUALITY ENGINEERING**  
3 cr. (3 and 0)
- I E 665 FACILITIES PLANNING AND DESIGN**  
3 cr. (3 and 0)
- I E 673 MICROCOMPUTER APPLICATIONS IN INDUSTRIAL ENGINEERING**  
3 cr. (2 and 3)
- I E 682 SYSTEMS MODELING**  
3 cr. (3 and 0)
- I E 684 MUNICIPAL SOLID WASTE MANAGEMENT**  
(AG E 684) 3 cr. (3 and 0) S  
(E S E 684)
- I E 685 INDUSTRIAL SYSTEMS ENGINEERING**  
3 cr. (3 and 0)
- I E 686 PRODUCTION PLANNING AND CONTROL**  
3 cr. (3 and 0)
- I E 687 INDUSTRIAL SAFETY**  
3 cr. (3 and 0)



- I E 688 HUMAN FACTORS ENGINEERING**  
3 cr. (3 and 0)
- I E 689 INDUSTRIAL ERGONOMICS**  
3 cr. (2 and 3)
- I E 691 SELECTED TOPICS IN INDUSTRIAL ENGINEERING**  
1-3 cr. (0-3 and 0-9)
- I E 692 DESIGN TOPICS IN INDUSTRIAL ENGINEERING**  
1-3 cr. (1-3 and 0)
- I E 801 DESIGN AND ANALYSIS OF HUMAN-MACHINE SYSTEMS**  
3 cr. (3 and 0)  
Methodologies used in the design and evaluation of human-machine systems, including function and task analysis; questionnaires and interviews; scenarios, mockups and prototypes; participative design, empirical testing and iterative design; models of human-system interaction; analysis and classification of human error; and design of job performance and training aids. **Prerequisites:** Graduate standing and permission of instructor.
- I E 802 DESIGN OF HUMAN-COMPUTER SYSTEMS**  
3 cr. (3 and 0)  
Issues in designing, implementing, maintaining and refining the user interface of interactive computer systems, including interface design theories, models, principles and guidelines; interaction styles; input and output devices; system messages; screen design, manuals, on-line help and tutorials; and iterative design, testing and evaluation. **Prerequisite:** I E 801 or permission of instructor.
- I E 803 ENGINEERING OPTIMIZATION AND APPLICATIONS**  
3 cr. (3 and 0)  
Introduction to optimization through the study of problems related to the planning, design and control of production/manufacturing systems. Topics include classical nonlinear optimization and algorithmic procedures, primal and dual problems with postoptimality analysis, Markov chains and selected topics. **Prerequisites:** Graduate standing and permission of instructor.
- I E 804 MANUFACTURING SYSTEMS PLANNING AND DESIGN**  
3 cr. (3 and 0)  
Concepts and principles associated with the design of manufacturing systems with a focus on modeling and integration methodologies. Topics include group technology, process planning, manufacturing modeling and design for manufacturing. **Prerequisites:** Graduate standing and permission of instructor.
- I E 805 FOUNDATIONS IN QUALITY ENGINEERING**  
3 cr. (3 and 0)  
Fundamental tools of quality engineering and their application to real situations. Topics include advanced statistical process control, design of experiments, Taguchi techniques and Shainin methodologies. **Prerequisites:** Graduate standing and permission of instructor.
- I E 807 DISCRETE SYSTEMS SIMULATION**  
3 cr. (3 and 0)  
Discrete and Monte Carlo simulation used to model and study stochastic operational systems; simulation languages GPSS V, SLAM and/or SIMAN. **Prerequisite:** Introductory statistics or permission of instructor.
- I E 808 CONTINUOUS SYSTEMS SIMULATION**  
3 cr. (3 and 0)  
Continuous systems simulation including systems with feedback and analysis of such systems, emphasizing industrial and management applications. **Prerequisite:** I E 807.
- I E 811 HUMAN FACTORS IN QUALITY CONTROL**  
3 cr. (3 and 0)  
Aspects of use of the human as a detector of product quality, serving as the basis for a taxonomy of human tasks in inspection; incorporates models of visual search and human decision making within the quality control framework. **Prerequisites:** Graduate standing and permission of instructor.
- I E 860 DYNAMIC PROGRAMMING**  
3 cr. (3 and 0)  
Theory and methodology of dynamic programming; Bellman's principle of optimality; Mitten's sufficiency conditions; recursive optimization of serial and nonserial multistage systems; optimization of discrete and continuous systems through decomposition; emphasis is on special aspects of problem formulation. **Prerequisite:** I E 803.
- I E 861 NONLINEAR PROGRAMMING**  
3 cr. (3 and 0)  
Methods for nonlinear, continuous problems; classical optimization; separable programming; quadratic programming; geometric programming; gradient methods; feasible directions; accelerating adaptive direct search methods. **Prerequisite:** I E 803.
- I E 865 FACILITY PLANNING AND DESIGN**  
3 cr. (3 and 0)  
Planning and design of industrial facilities emphasizing automated production facilities; quantitative approaches to equipment design and evaluation of performance. **Prerequisite:** I E 803.
- I E 871 INDUSTRIAL TESTING AND QUALITY**  
3 cr. (3 and 0)  
Design and use of component and product tests; automated inspection; test and inspection in integrated systems; cost-based models. **Prerequisite:** I E 661.



- I E 872 DESIGN FOR QUALITY**  
3 cr. (3 and 0)  
Advanced quality engineering techniques with application to design of products and processes. Topics include advanced statistical techniques as well as contemporary modifications such as Taguchi and Shainin methodologies. **Prerequisites:** I E 805 and EX ST 805.
- I E 873 COMPUTER-AIDED MANUFACTURING**  
3 cr. (2 and 3)  
Principles associated with automated manufacturing systems, emphasizing computer control and real time concepts. Topics include NC, GT, PLC, robotics, process planning, real time control and networking. **Prerequisites:** Graduate standing and permission of instructor.
- I E 880 ADVANCED METHODS OF OPERATIONS RESEARCH**  
3 cr. (3 and 0)  
Methods and applications of advanced operations research techniques. Topics may include discrete optimization, integer and mixed integer programming, Boolean minimization, network optimization, permutization methods on implicit enumeration. **Prerequisite:** I E 803 or permission of instructor.
- I E 884 ADVANCED ENGINEERING ECONOMIC ANALYSIS**  
3 cr. (3 and 0)  
Engineering economic analysis for engineering research, development and construction projects, emphasizing detailed treatment of tax effects, methods for determining discount rates, proper use of economic criteria in various decision environments (certainty vs. uncertainty, single vs. multiple project selections, etc.). **Prerequisite:** Permission of instructor.
- I E 885 DESIGN AND ANALYSIS OF SIMULATION MODELS**  
3 cr. (3 and 0)  
Design and validation of operations research-type simulation models; statistical analysis of input and output data of these models. **Prerequisites:** I E 807 and MA SC 814 or permission of instructor.
- I E 886 OPERATIONS RESEARCH IN PRODUCTION CONTROL**  
3 cr. (3 and 0)  
Latest techniques in scientific inventory management, scheduling and forecasting; operations research; statistics; computer methods; case studies. **Prerequisite:** I E 803.
- I E 888 APPLIED QUEUEING THEORY AND MARKOV PROCESSES**  
3 cr. (3 and 0)  
Advanced treatment of stochastic optimization, potentially including single and multiple channel queues, Markov programming and stochastic optimal control. **Prerequisite:** I E 860 or permission of instructor.
- I E 890 SPECIAL PROBLEMS IN INDUSTRIAL ENGINEERING**  
1-3 cr. (1-3 and 0)  
Principles and methods of industrial engineering applied to analysis of a current interest problem. May be repeated for additional credit. Graded on a pass/fail basis. **Prerequisite:** Permission of instructor.
- I E 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- I E 892 MASTER'S DESIGN PROJECT**  
3 cr. (1 and 6)  
Design project in industrial systems; integration of IE principles and methodologies; resolution of contemporary systems design problems; project requires research, development, implementation planning, reporting and project assessment. **Prerequisite:** Permission of instructor.
- I E 893 SELECTED TOPICS IN INDUSTRIAL ENGINEERING**  
1-3 cr. (1-3 and 0)  
Selected topics in industrial engineering emphasizing new developments in systems science, systems analysis and operations research. May be repeated for additional credit. **Prerequisite:** Permission of instructor.
- I E 895 INDUSTRIAL ENGINEERING RESEARCH TECHNIQUES**  
1 cr. (1 and 0)  
Series of weekly, one-hour lectures given by students, faculty and guests on methods and issues involved in industrial engineering research. Graded on a pass/fail basis.
- I E 907 PRODUCTION SYSTEMS SIMULATION**  
3 cr. (2 and 3)  
Simulation modeling of production systems with emphasis on significant design and control issues in automated manufacturing. **Prerequisite:** I E 807.
- I E 971 ADVANCED QUALITY ENGINEERING SEMINAR**  
3 cr. (3 and 0)  
Current topics in the research and development of quality engineering methodologies. **Prerequisite:** I E 871 or permission of instructor.
- I E 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

### Mechanical Engineering

Richard S. Figliola, Chair, Department of Mechanical Engineering

Major	Degrees
Mechanical Engineering	M.Engr., M.S., Ph.D.

Students are accepted for the Master of Engineering degree program with undergraduate degrees in mechanical engineering (or equivalent) from ABET-accredited programs. Enrollment in the M.S. and Ph.D. programs is open to those students with degrees in physics, applied mathematics or any branch of engineering.

Students in the M.S. degree program may choose the thesis or nonthesis option. Students in the thesis program must complete



30 hours of course work, including six hours of thesis research. Students in the nonthesis program and in the M.Engr. program must complete 33 hours of course work, including six hours of project-related credits. Students in the Ph.D. program must complete 18 hours of dissertation research.

Programs may be selected with concentrations in mechanical and manufacturing systems design (CAD/CAM, kinematics and dynamics, materials, robotics and vibrations) or thermal/fluid sciences (fluid mechanics, heat transfer, thermodynamics and energy systems).

- M E 607**      **APPLIED HEAT TRANSFER**  
3 cr. (3 and 0)
- M E 617**      **CONTROL SYSTEMS DESIGN**  
3 cr. (2 and 1)
- M E 620**      **ENERGY SOURCES AND THEIR UTILIZATION**  
3 cr. (3 and 0)
- M E 621**      **INTRODUCTION TO COMPRESSIBLE FLOW**  
3 cr. (3 and 0)
- M E 622**      **DESIGN OF GAS TURBINES**  
3 cr. (3 and 0)
- M E 623**      **INTRODUCTION TO AERODYNAMICS**  
3 cr. (3 and 0)
- M E 625**      **KINEMATICS AND DYNAMICS OF MACHINERY II**  
3 cr. (3 and 0)
- M E 629**      **THERMAL ENVIRONMENTAL CONTROL**  
3 cr. (3 and 0)
- M E 653**      **DYNAMIC PERFORMANCE OF VEHICLES**  
3 cr. (3 and 0)
- M E 654**      **DESIGN OF MACHINE ELEMENTS**  
3 cr. (3 and 0)
- M E 655**      **DESIGN FOR COMPUTER-AUTOMATED MANUFACTURING**  
3 cr. (3 and 0)
- M E 656**      **FUNDAMENTALS OF ROBOTICS**  
(E C E 656) 3 cr. (3 and 0)
- M E 693**      **SELECTED TOPICS IN MECHANICAL ENGINEERING**  
1-6 cr. (3 and 0)
- M E 801**      **FOUNDATIONS OF FLUID MECHANICS**  
3 cr. (3 and 0)  
Derivations of basic equations for multidimensional flow fields; analytical techniques for solving problems in laminar viscous flow and laminar inviscid flow; theories of similitude. **Prerequisites:** Graduate standing and permission of instructor.
- M E 810**      **MACROSCOPIC THERMODYNAMICS**  
3 cr. (3 and 0)  
First, second and third laws of thermodynamics with engineering applications; thermodynamic property relations; chemical equilibrium. **Prerequisite:** M E 312 or equivalent.

- M E 811**      **GAS DYNAMICS**  
3 cr. (3 and 0)  
Concepts from thermodynamics, one-dimensional gas dynamics, one-dimensional wave motion, normal and oblique shocks; flow in ducts and wind tunnels; two-dimensional equation of motion; small perturbation theory. **Prerequisite:** Undergraduate course in fluid mechanics.
- M E 812**      **EXPERIMENTAL METHODS IN THERMAL SCIENCE**  
3 cr. (2 and 2)  
Theories of measurements, instrumentation and techniques for measuring temperature, pressure and velocity on a practical graduate engineering level; mathematical presentation of data, uncertainty analysis, data acquisition techniques, and theory and state-of-the-art measuring systems.
- M E 814**      **CONCEPTS OF TURBULENT FLOW**  
3 cr. (3 and 0)  
Concepts of fluid turbulence; turbulent transport mechanisms, dynamics of turbulence and experimental techniques pertinent to existing theories. Topics address classification of shear flows and their prediction methods. **Prerequisite:** M E 801.
- M E 815**      **STATISTICAL THERMODYNAMICS I**  
(PHYS 815) 3 cr. (3 and 0)  
See PHYS 815 for description.
- M E 818**      **INTRODUCTION TO FINITE ELEMENT ANALYSIS**  
3 cr. (3 and 0)  
Introduction to the finite element method; applications to heat transfer, fluid flow and solids; introduction to transient analysis; analysis strategies using finite elements; introduction to solid modeling, finite element modeling and analysis using commercial codes. **Prerequisite:** A numerical methods course or permission of instructor.
- M E 819**      **COMPUTATIONAL METHODS IN THERMAL SCIENCES**  
3 cr. (3 and 0)  
Numerical techniques as applied to the solution of fluid flow and heat transfer problems; emphasis is primarily on the use of finite difference methods. **Prerequisite:** Graduate standing.
- M E 820**      **MODERN CONTROL ENGINEERING**  
3 cr. (3 and 0)  
Mathematical modeling of engineering systems using differential and difference state equations; state variable time solutions using analytic and computer-aided analysis techniques; state control principles of controllability, observability, stability and performance specification; trade-offs between state variable and transfer function techniques. **Prerequisite:** An undergraduate controls course or permission of instructor.



- M E 821 ADVANCED CONTROL ENGINEERING**  
3 cr. (3 and 0)  
Concepts in multivariable, nonlinear, stochastic and optimal control engineering; design and analysis considerations related to physical machines and processes; mathematical methods as needed. **Prerequisite:** An undergraduate controls course or permission of instructor.
- M E 822 COMPUTER CONTROL OF AUTOMATED MACHINES**  
3 cr. (3 and 0)  
Concepts for control of automated manufacturing machines, cells and processes; logic and switching control; programmable controllers; supervisory hierarchical and expert control systems concepts for manufacturing; closed-loop direct digital control design, including sampling, stability and response of discrete system models; design and application of computer control algorithms; computer requirements; sensors and signal conversion. **Prerequisite:** M E 820 or permission of instructor.
- M E 830 CONDUCTION HEAT TRANSFER**  
3 cr. (3 and 0)  
Analytical and numerical solutions of conduction heat transfer problems; steady one- and two-dimensional systems; extended surfaces; transient solutions; numerical solutions; transform methods. **Prerequisites:** M E 304 or equivalent and Graduate School enrollment.
- M E 831 CONVECTIVE HEAT TRANSFER**  
3 cr. (3 and 0)  
Derivation of continuity, momentum and energy equations for boundary layer flow; solutions for confined and external flow regimes in laminar and turbulent flow. **Prerequisites:** M E 304 or equivalent and MTHSC 208.
- M E 832 RADIATIVE HEAT TRANSFER**  
3 cr. (3 and 0)  
Radiation properties; enclosure theory; radiation exchange between solid bodies; radiation exchange in the presence of absorbing, transmitting and emitting media; combined radiation, conduction and convection exchange. **Prerequisites:** M E 304 or equivalent and permission of instructor.
- M E 833 HEAT TRANSFER WITH CHANGE OF PHASE**  
3 cr. (3 and 0)  
Nucleate boiling in a pool; film boiling in a pool; forced nucleate boiling; forced film boiling; effect of impurities on boiling phenomena; dropwise condensation; filmwise condensation; effect of noncondensable gases on condensation; boiling and condensing processes in systems. **Prerequisites:** M E 304 or equivalent and permission of instructor.
- M E 841 ADVANCED MECHANICAL ENGINEERING DESIGN I**  
3 cr. (3 and 0)  
Design projects selected from industry or government addressed by a graduate student/faculty design team; students are required to create and structure a problem solution, the solution being a preliminary design study encompassing analysis, synthesis, evaluation, economic cost/benefit considerations and engineering project organization. **Prerequisite:** Graduate standing or permission of instructor.
- M E 842 ADVANCED MECHANICAL ENGINEERING DESIGN II**  
3 cr. (3 and 0)  
Case study method of individual design problems and projects; cases used as basis for problem formulation, problem analysis, design theory exemplification, and class discussion and evaluation; principles of mechanical and engineering sciences introduced and applied as required for case considerations. **Prerequisite:** M E 306 or equivalent or permission of instructor.
- M E 843 NONLINEAR DYNAMICS OF MECHANICAL SYSTEMS**  
3 cr. (3 and 0)  
Behavior of nonlinear mechanical systems analyzed with numerical, graphical and analytical methods; emphasis on understanding nonlinear effects and methods of analysis. **Prerequisite:** Graduate standing and/or permission of instructor.
- M E 844 RANDOM VIBRATION: THEORY AND MEASUREMENT**  
3 cr. (3 and 0)  
Analysis and measurement of random phenomena. Topics include description of random phenomena (probability theory, response of systems to random phenomena and digital signal processing theory); use of spectrum analyzer and other digital signal recording instruments. **Prerequisites:** M E 302 or MTHSC 208 and permission of instructor.
- M E 845 VIBRATION OF CONTINUOUS MEDIA**  
3 cr. (3 and 0)  
Fundamental principles of generation, propagation, absorption, reflection and scattering of vibrational wave in solids and fluids; free and forced oscillation of flexible strings, bars, membranes and plates; theory of wave motion in liquids and gases. **Prerequisite:** Permission of instructor.
- M E 854 ANALYSIS OF ROBOTIC SYSTEMS**  
(E C E 854)  
3 cr. (3 and 0)  
See E C E 854 for description.
- M E 859 INTELLIGENT ROBOTIC SYSTEMS**  
(E C E 859)  
3 cr. (3 and 0)  
See E C E 859 for description.
- M E 890 ENGINEERING PROJECT**  
1-3 cr. (0 and 3-9)  
Comprehensive analytical and/or experimental treatment of phenomena of current interest in mechanical engineering emphasizing modern technological problems. May be repeated for a maximum of nine credits.
- M E 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.



- M E 893** **SELECTED TOPICS IN MECHANICAL ENGINEERING**  
1-6 cr. (1-6 and 0)  
Topics not covered in other courses. May be repeated for credit.
- M E 930** **ADVANCED TOPICS IN HEAT TRANSFER**  
1-6 cr. (1-6 and 0)  
Topics not covered in other courses. May be repeated for a maximum of six credits.
- M E 931** **ADVANCED TOPICS IN FLUID MECHANICS**  
3 cr. (3 and 0)  
Topics not covered in other courses. May be repeated for a maximum of six credits.
- M E 932** **ADVANCED TOPICS IN THERMODYNAMICS**  
3 cr. (3 and 0)  
Topics not covered in other courses. May be repeated for a maximum of six credits.
- M E 991** **DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

### *School of Textiles, Fiber and Polymer Science*

Douglas V. Rippey, Director

### **Textile and Polymer Science**

Douglas V. Rippey, Director, School of Textiles, Fiber and Polymer Science

Major	Degree
Textile and Polymer Science	Ph.D.

Qualification to pursue the degree is accomplished by obtaining a grade of A or B in at least five courses representative of the major areas of textile and polymer science or by standing special examinations in these courses. Courses currently considered representative are TEXT 821, Fiber Physics I; TEXT 835, Textile Structures I; TEXT 866, Fiber Formation; T C 811, Polymer Science I; and T C 812, Polymer Science II.

Other courses, tailored to the individual's objectives, are selected by the student and his or her advisory committee. The student normally takes a minor in a selected field of science or engineering and satisfies the requirements established by the minor department. This usually involves 12-24 credit hours in the minor field. A reading knowledge of one foreign language selected by the advisory committee also is required.

Admission to candidacy for the Ph.D. degree requires completion of written and oral comprehensive examinations. Each candidate must carry out an independent, original scientific investigation and formally report and defend the methodology, results and conclusions.

### **Textile Chemistry**

Douglas V. Rippey, Director, School of Textiles, Fiber and Polymer Science

Major	Degrees
Textile Chemistry	M.S., Ph.D.*

Applicants must have a bachelor's degree in textile chemistry, textile science, the physical or life sciences, engineering or a related discipline, and must have training in chemistry, physics and mathematics.

\* A Ph.D. degree with a concentration in textile chemistry is offered jointly by the School of Textiles, Fiber and Polymer Science and the Department of Chemistry.

The M.S. degree requires a minimum of 24 credit hours of course work and six credit hours of research.

The student's major area of study is normally fiber chemistry, polymer chemistry, the chemistry of dyeing and/or finishing of fibers and textiles, or the chemistry of composite systems. The minor area of study is usually chemistry, physics, engineering, life sciences or mathematics. Each candidate must complete an independent, scientific or technical investigation and formally report and defend the methodology, results and conclusions in a thesis.

- T C 615** **INTRODUCTION TO POLYMER SCIENCE AND ENGINEERING**  
3 cr. (3 and 0) F
- T C 616** **CHEMICAL PREPARATION OF TEXTILES**  
3 cr. (2 and 3) S
- T C 657** **DYEING AND FINISHING I**  
3 cr. (3 and 0) F
- T C 658** **DYEING AND FINISHING II**  
3 cr. (3 and 0) S
- T C 659** **DYEING AND FINISHING LABORATORY I**  
1 cr. (0 and 3) F
- T C 811** **POLYMER SCIENCE I**  
3 cr. (3 and 0) F  
Fundamentals of polymer chemistry; chemistry and synthesis of monomers and polymers discussed in relation to the thermodynamics, kinetics and mechanisms of polymerization reactions emphasizing fiber-forming polymers, plastics and composite matrix materials.
- T C 812** **POLYMER SCIENCE II**  
3 cr. (3 and 0) S  
Chemical structure and properties of polymers; polymer solution properties, the viscoelastic state and the crystalline morphology of polymeric materials; the current theories for describing polymer thermal transitions, molecular weight, molecular weight distributions, and transport phenomena in polymeric systems, as well as interfacial phenomena.
- T C 820** **COMPOSITE POLYMERIC MATERIALS**  
(CH E 820)  
3 cr. (3 and 0) N  
See CH E 820 for description.
- T C 840** **ANALYTICAL METHODS IN TEXTILE AND POLYMER SCIENCE**  
3 cr. (3 and 0) S  
Use of chemical and physical instrumental methods to characterize polymeric materials in textile and polymer science; basic principles are discussed and the unique problems encountered when techniques such as IR, NMR, GC, LC, MS, GC/MS and thermal analysis, microscopy and tensile testing are applied to polymeric materials are emphasized. **Prerequisite:** Permission of instructor.
- T C 891** **MASTER'S THESIS RESEARCH**  
Credit to be arranged.



## Textile Science

Douglas V. Rippy, Director, School of Textiles, Fiber and Polymer Science

**Major**  
Textile Science

**Degree**  
M.S.

Applicants must have a bachelor's degree in textile chemistry, textile science, the physical or life sciences, engineering or related disciplines, and must have training in chemistry, physics and mathematics.

The student's major area of study is usually fiber science, polymer science or textile technology. The minor area of study normally is the life or physical sciences, engineering, mathematics or management. The thesis option requires each student to complete a minimum of 24 credit hours of course work and six credit hours of research, an independent, scientific or technical investigation, and formally report and defend the methodology, results and conclusions in a thesis.

The nonthesis option requires a total of 36 hours of course work with a net grade point average of 3.0. The option consists of a core group of courses that totals 24 hours with 12 additional approved hours of the student's choice. Successful performance in a comprehensive oral examination also is required. This program is geared specifically only to those with five years of industrial experience who are currently employed in the textile industry and who view the Master of Science as a terminal degree. Further information can be obtained from the director of the School of Textiles, Fiber and Polymer Science.

<b>TEXT 611</b>	<b>FABRIC DEVELOPMENT III</b> 3 cr. (2 and 2) F
<b>TEXT 616</b>	<b>NONWOVEN STRUCTURES</b> 3 cr. (2 and 2) S (even numbered years)
<b>TEXT 621</b>	<b>FIBER SCIENCE</b> 3 cr. (2 and 2) F
<b>TEXT 622</b>	<b>PROPERTIES OF TEXTILE STRUCTURES</b> 3 cr. (2 and 2) S
<b>TEXT 626</b>	<b>INSTRUMENTATION</b> 3 cr. (3 and 0) S
<b>TEXT 640</b>	<b>COLOR SCIENCE</b> 3 cr. (2 and 3) N
<b>TEXT 660</b>	<b>TEXTILE PROCESSES</b> 3 cr. (3 and 0) F, S
<b>TEXT 672</b>	<b>TEXTILE INTERNATIONAL TRADE</b> 3 cr. (3 and 0) N
<b>TEXT 675</b>	<b>TEXTILE MARKETING</b> 3 cr. (3 and 0) S
<b>TEXT 676</b>	<b>CARPET MANUFACTURING</b> 3 cr. (3 and 0) S (odd numbered years)
<b>TEXT 821</b>	<b>FIBER PHYSICS I</b> 3 cr. (3 and 0) F Fiber physical properties and their relationship to fiber structure; methods of investigating fiber structure and physical properties; theories of viscoelastic behavior and thermal properties, and models of fiber structure.
<b>TEXT 822</b>	<b>FIBER PHYSICS II</b> 3 cr. (3 and 0) S Extension of TEXT 821, providing a more in-depth study of the mathematics of polymer fiber

viscoelasticity and the solid state thermodynamics of polymeric systems; properties of copolymers, polymer optical and electrical properties; radiation physics of polymers. **Prerequisites:** TEXT 821 and MTHSC 208 or permission of instructor.

### TEXT 830

#### TEXTILE PHYSICS

3 cr. (3 and 0) F

Physical principles underlying manufacturing environments in which fibers, yarns and fabrics are produced; physical and mathematical techniques are developed for the study and analysis of the textile plant environment, controls and energy requirements. **Prerequisite:** Graduate standing.

### TEXT 835

#### TEXTILE STRUCTURES I

3 cr. (3 and 0) F

Pioneering works relating fiber properties to yarn properties; yarn geometry, fiber arrangements in twisted yarns, extension and breakage of continuous filament yarns, and deformation of staple fiber yarns.

### TEXT 845

#### GEOTEXTILES AND GEOMEMBRANES IN ENGINEERING STRUCTURES

3 cr. (3 and 0) N

Theory and practice of the application of textile materials used in civil engineering constructions, design methods and technological advances; fundamentals of soil mechanics and the manufacture of the textile material; testing and evaluation of the materials. **Prerequisite:** Permission of instructor.

### TEXT 846

#### TEXTILE STRUCTURES II

3 cr. (3 and 0) S

Recent advances in the theoretical and experimental studies on fabric structures, structural mechanics of woven, knitted and nonwoven fabrics; relationship between yarn geometry and fabric structure; design of industrial fabrics and laminated structures. **Prerequisite:** Permission of instructor.

### TEXT 866

#### FIBER FORMATION

3 cr. (3 and 0) S

Formation of fibers by wet, dry and melt spinning, emphasizing rheology of solutions and melts, fiber structure, stretching and drawing processes; interrelationships of polymer properties and processes that determine fiber properties.

### TEXT 870

#### ADVANCES IN TEXTILE MANUFACTURING

3 cr. (3 and 0) N

Comparisons among cotton, woolen and worsted processing systems with respect to suitability to fiber characteristics, processing of fiber blends, modern yarn production, nonwoven fabrics and latest developments in textile machinery.

### TEXT 880

#### SELECTED TOPICS

3 cr. (3 and 0) N

Topics not covered in other textile chemistry or textile science courses.



**TEXT 888 SEMINAR**  
1 cr. (1 and 0)  
Students, under the direction of their major adviser, review current topics in textiles, fiber and polymer science. May be repeated for a maximum of five credits. **Prerequisite:** Graduate standing or permission of undergraduate adviser.

**TEXT 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.

**TEXT 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

*These programs are directed by a council of the department chairs.*

## Agricultural Engineering

Joseph M. Bunn, Chair, Department of Agricultural and Biological Engineering

<b>Major</b>	<b>Degrees</b>
Agricultural Engineering	M.Engr., M.S., Ph.D.

Graduate programs in agricultural engineering are designed to prepare the individual for leadership, creative accomplishment and continued professional learning, and to qualify the student to conduct independent scientific research.

Students may be accepted with backgrounds in quantitative-based scientific fields relating to chemistry, mathematics, physics, biology or any branch of engineering. A number of undergraduate prerequisite or corequisite courses may be required for applicants with undergraduate degrees in nonengineering disciplines.

Each degree program is planned individually to augment the student's previous engineering and science background with adequate breadth in engineering and specialization in an area of agricultural engineering. Course work, in addition to agricultural engineering, consists of mathematics, physics, chemistry, statistics, and biological and engineering sciences.

Candidates for the M.Engr. degree must complete a minimum of 30 hours of course work as outlined by the advisory committees. A thesis is not required for this degree. Candidates for the M.S. degree are required to complete a minimum of 24 hours of course work plus an additional six hours of thesis research.

Candidates for the Ph.D. degree are required to complete an additional 36 semesters hours of course work beyond the M.S. degree. Also required is the completion of 18 hours of dissertation research and the submission of an acceptable dissertation.

**AG E 608 LAND TREATMENT OF WASTEWATER AND SLUDGES**  
(E S E 608) 3 cr. (3 and 0) F  
(AGRON 608)

**AG E 616 MECHANICAL DESIGN FOR AGRICULTURAL AND BIOLOGICAL SYSTEMS**  
3 cr. (2 and 3) S

**AG E 628 BIOCHEMICAL ENGINEERING**  
(CH E 628) 3 cr. (3 and 0)

**AG E 630 ENGINEERING MODELING OF BIOLOGICAL SYSTEMS**  
(BIOSC 630) 3 cr. (3 and 0)

**AG E 631 AGRICULTURAL STRUCTURES AND ENVIRONMENTAL DESIGN**  
3 cr. (2 and 3) F

**AG E 642 PROPERTIES AND PROCESSING OF BIOLOGICAL PRODUCTS**  
3 cr. (2 and 3) S

**AG E 650 INSTRUMENTATION FOR AGRICULTURAL AND BIOLOGICAL SYSTEMS**  
3 cr. (2 and 3)

**AG E 651 NEWMAN SEMINAR AND LECTURE SERIES IN NATURAL RESOURCES ENGINEERING**  
(E SE651) 1 cr. (0 and 2) S, F  
(FOR651)

**AG E 658 CELL PHYSIOLOGY**  
(BIOSC 658) 3 cr. (3 and 0)

**AG E 684 MUNICIPAL SOLID WASTE MANAGEMENT**  
(E S E 684) 3 cr. (3 and 0) S  
(I E 684)

**AG E 781 SPECIAL PROBLEMS**  
1-3 cr. (1-3 and 0)  
Student selects subject and conducts library, laboratory and/or field research; technical report documenting study required. May be repeated for maximum of six credits. For Master of Engineering degree candidates only.

**AG E 811 TILLAGE AND SOIL DYNAMICS**  
3 cr. (3 and 0)  
Physical and dynamic properties of soil related to actions of tillage tools, tractive vehicles and plant growth and development; soil strength parameters; seedling environment and emergence; mechanics of tillage implements; soil compaction causes and effects; tractive efforts of wheel and track-type vehicles; off-the-road locomotion. **Prerequisite:** AG E 416/616 or equivalent.

**AG E 865 HEAT AND MOISTURE TRANSFER IN BIOLOGICAL MATERIALS**  
3 cr. (3 and 0)  
Heat and moisture diffusion in biological materials; criteria for selecting proper operational mathematics to solve certain boundary value problems; integral transforms of Laplace, Fourier and Hankel applied to various geometric configurations; influence of respiration heat and transpiration moisture production. **Prerequisite:** MTHSC 453/653 or 434/634 or permission of instructor.

**AG E 871 SELECTED TOPICS IN AGRICULTURAL ENGINEERING**  
1-3 cr. (1-3 and 0)  
Supervised, in-depth study of an area not covered in other courses; performance measured by oral and written reports and/or by examination. May be repeated for a maximum of six credits.

**AG E 882 SYSTEMS ENGINEERING**  
3 cr. (3 and 0)  
Systems analysis methods applied to engineering of biological and agricultural operations; development of equations of motion, system analogs, and computer models and simulations; linear control analysis; and stability. **Prerequisite:** Permission of instructor.

**AG E 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.



**AG E 901 SPECIAL PROBLEMS IN AGRICULTURAL ENGINEERING**  
3 cr. (3 and 0)  
Library and/or laboratory research on one of the following subjects, depending on student's field of study or interests: power and machinery, soil and water resources, farm structures, electric power and processing, food engineering, forest engineering or waste management; technical report required.

**AG E 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

## Chemistry

Adolph L. Beyerlein, Chair, Department of Chemistry

**Major**  
Chemistry

**Degrees**  
M.S., Ph.D.

Degree concentrations are offered in analytical, inorganic, organic and physical chemistry. Research areas also include bio-organic chemistry, polymer chemistry and chemical physics. A Ph.D. degree in chemistry with a concentration in textile chemistry is offered jointly with the School of Textiles, Fiber and Polymer Science.

Students in either degree program must present satisfactory research seminars and must complete, or have completed, a computer science course equivalent to Clemson University's CP SC 110. In some instances, the computer science course requirement may be waived for candidates for the M.S. degree who have completed satisfactorily undergraduate courses in French, German or Russian. Students in the Ph.D. program must pass a language requirement in French, German or Russian.

Master of Science degree candidates must complete 24 hours of course work and six hours of research culminating in a satisfactory thesis.

The primary requirement for the Ph.D. degree is the performance of original research leading to a dissertation. Doctor of Philosophy degree candidates must qualify to pursue the Ph.D. degree by completing a core of four courses with at least a B average during the first two years of study. The core courses are taken in four areas: one in organic, one in physical and two selected from analytical, inorganic and biochemistry. Qualification requirements may also be satisfied by examination.

Admission to candidacy for the Ph.D. degree requires completion of either a cumulative or a comprehensive examination in the area of concentration. The examination, the type of which depends upon the area selected by the student, may be followed by an oral presentation before a faculty committee.

**CH 602 INORGANIC CHEMISTRY**  
3 cr. (3 and 0) F

**CH 611 INSTRUMENTAL ANALYSIS**  
3 cr. (3 and 0) S

**CH 621 ADVANCED ORGANIC CHEMISTRY**  
3 cr. (3 and 0)

**CH 627 ORGANIC SPECTROSCOPY**  
3 cr. (2 and 3) S (odd numbered years)

**CH 631 PHYSICAL CHEMISTRY I**  
3 cr. (3 and 0) F, S

**CH 632 PHYSICAL CHEMISTRY II**  
3 cr. (3 and 0) F, S

**CH 635 ATOMIC AND MOLECULAR STRUCTURE**  
3 cr. (3 and 0) S

**CH 639 PHYSICAL CHEMISTRY LABORATORY I**  
1 cr. (0 and 3) F

**CH 640 PHYSICAL CHEMISTRY LABORATORY II**  
1 cr. (0 and 3) S

**CH 700 PHYSICAL SCIENCE IN ELEMENTARY SCHOOL — CHEMISTRY**  
3 cr. (2 and 3) N  
Basic chemical principles and their applications to everyday life; selecting, carrying out and discussing short, safe, inexpensive experiments to illustrate the principles. Restricted to graduate students in elementary education. Graduate students in secondary education may take the course by special permission of the instructor.

**CH 804 FUNDAMENTAL PRINCIPLES OF INORGANIC CHEMISTRY**  
3 cr. (3 and 0) F  
Fundamental principles of modern inorganic chemistry showing their relationship to other areas of chemistry.

**CH 805 THEORETICAL INORGANIC CHEMISTRY**  
3 cr. (3 and 0) S (odd numbered years)  
Application of group theory to structure and properties of inorganic molecules. **Prerequisites:** CH 435/635 and 804 or permission of instructor.

**CH 806 PHYSICAL METHODS IN INORGANIC CHEMISTRY**  
3 cr. (3 and 0) S (odd numbered years)  
Theory and application of infrared, Raman, visible, ultraviolet, NMR, ESR, NQR, Mössbauer and mass spectrometry to inorganic chemistry. **Prerequisite:** CH 804 or permission of instructor.

**CH 807 CHEMISTRY OF THE TRANSITION ELEMENTS**  
3 cr. (3 and 0) F  
Structure, spectroscopy and reactivity of transition metals and their compounds. **Prerequisite:** CH 804 or permission of instructor.

**CH 808 CHEMISTRY OF THE NONMETALLIC ELEMENTS**  
3 cr. (3 and 0) S (odd numbered years)  
Development and application of a bonding model for descriptive inorganic chemistry of boron, carbon, silicon, nitrogen, phosphorus, oxygen and sulfur. **Prerequisite:** CH 804 or permission of instructor.

**CH 809 CHEMICAL APPLICATIONS OF X-RAY CRYSTALLOGRAPHY**  
3 cr. (2 and 2) S (odd numbered years)  
Topics include a physical description of the crystalline state, symmetry in crystals, X-ray diffraction, modern methods of structure determination and chemical interpretation of structural results. **Prerequisite:** CH 331, 332 or permission of instructor.



- CH 811 ANALYTICAL CHEMISTRY**  
3 cr. (3 and 0) F  
Graduate-level review of modern analytical chemistry; literature, sampling, quality control/ assurance, chemometrics and the use of modern analytical methods are stressed; team taught by the analytical faculty.
- CH 812 CHEMICAL SPECTROSCOPIC METHODS**  
3 cr. (2 and 3) S  
Emission and absorption spectroscopy, chemical microscopy, X-ray diffraction and fluorescence techniques in analytical chemistry; theory and operation of instruments.
- CH 813 ELECTROCHEMICAL SCIENCE**  
3 cr. (3 and 0)  
Theory and experimental study of electrochemical thermodynamics, electrified interfaces, interfacial charge transfer, electrolyte solutions, electrode processes and membrane electrochemistry; amperometric, voltammetric, electrolytic and potentiometric methods; practical applications of electrochemistry in analysis, materials synthesis and energy technology. **Prerequisite:** Graduate standing in chemistry or chemical engineering, or permission of instructor.
- CH 816 SEPARATION SCIENCE**  
3 cr. (3 and 0) S (odd numbered years)  
Fundamental thermodynamic and kinetic concepts of separation and practical aspects of current separation techniques used in analytical chemistry.
- CH 820 FUNDAMENTALS OF ORGANIC SYNTHESIS**  
3 cr. (3 and 0) F  
Modern aspects of organic chemistry emphasizing the mechanisms of reactions and synthesis of molecules of current interest. **Prerequisites:** CH 224 or equivalent plus satisfactory performance in the organic placement examination or permission of instructor.
- CH 821 ORGANIC CHEMISTRY I**  
3 cr. (3 and 0) F  
Theoretical concepts of organic chemistry, stereochemistry and mechanisms of organic reactions. **Prerequisite:** CH 421/621 or satisfactory performance on the organic chemistry placement examination.
- CH 822 ORGANIC CHEMISTRY II**  
3 cr. (3 and 0) S  
Continuation of CH 821; mechanisms of organic reactions including photochemistry and Woodward-Hoffman rules; modern synthetic organic chemistry. **Prerequisite:** CH 821 or permission of instructor.
- CH 825 CHEMISTRY OF HETEROCYCLIC COMPOUNDS**  
3 cr. (3 and 0) S (odd numbered years)  
Chemistry of heterocyclic compounds of nitrogen, oxygen, sulfur and other elements. **Prerequisites:** CH 821 and/or CH 822 or permission of instructor.
- CH 830 FUNDAMENTALS OF PHYSICAL CHEMISTRY**  
3 cr. (3 and 0) F  
Principles of classical thermodynamics, chemical kinetics and quantum chemistry. **Prerequisite:** CH 331/631 or equivalent.
- CH 831 CHEMICAL THERMODYNAMICS**  
3 cr. (3 and 0) F (odd numbered years)  
Classical thermodynamics emphasizing theory and significance of energetics and systems of variable composition. **Prerequisite:** CH 331/631 or equivalent.
- CH 834 STATISTICAL THERMODYNAMICS**  
3 cr. (3 and 0) S (odd numbered years)  
Statistical thermodynamics: ensemble method, ideal gases, internal degrees of freedom, solid state, imperfect gases, distribution function method in fluids and time-dependent fluctuations. **Prerequisite:** CH 831.
- CH 835 CHEMICAL KINETICS**  
3 cr. (3 and 0) S (odd numbered years)  
Rate processes and reaction mechanisms; order of reaction; theory of rate processes; relation of reaction rates to mechanism; homogeneous and heterogeneous catalysis; experimental methods; chain reactions; diffusion; effects of solvent, temperature and pressure on reaction rates and mechanisms; lectures supplemented by assigned problems, paper and oral examination of topic of special interest to student.
- CH 837 QUANTUM CHEMISTRY**  
3 cr. (3 and 0) F (odd numbered years)  
Mathematical and conceptual formulation of quantum theory of electronic structure of atoms and molecules; eigenvalue solution of one-dimensional Schrodinger equation and application of this method to chemical problems.
- CH 840 TECHNIQUES OF EXPERIMENTAL CHEMISTRY**  
3 cr. (1 and 6) F, S  
Theory and practice in major experimental techniques used in chemical research; chromatography; NMR, IR, visible, UV and ORD/CD spectrophotometry; glassblowing and high vacuum techniques; mass spectrometry; ESR; Mössbauer spectrometry and tracer analysis.
- CH 841 CHEMICAL APPLICATIONS OF NMR SPECTROSCOPY**  
3 cr. (2 and 2)  
Basic concepts of NMR spectroscopy with application to organic, inorganic, physical and analytical chemistry; design of spectroscopic experiments and interpretation of spectra; modern techniques include multipulse, multinuclear and two-dimensional methods. **Prerequisites:** CH 331 and 332 or permission of instructor.
- CH 851 SEMINAR**  
1-2 cr. F, S  
Students and faculty review current topics in chemistry. May be taken more than one semester.



- CH 861 PRINCIPLES OF BIOCHEMISTRY**  
3 cr. (3 and 0) N  
Rigorous, quantitative treatment of properties of biological molecules using modern techniques of organic, physical and analytical chemistry to study structural relationships and biological activity. **Prerequisites:** Satisfactory performance on placement examinations in organic and physical chemistry.
- CH 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged. F, S, SS
- CH 900 SELECTED TOPICS IN INORGANIC CHEMISTRY**  
1-4 cr. (1-4 and 0) N  
Metal-metal bonding; homogeneous catalysis; photochemistry; bioinorganic chemistry. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.
- CH 910 SELECTED TOPICS IN ANALYTICAL CHEMISTRY**  
1-4 cr. (1-4 and 0) N  
New techniques and their applications in analytical chemistry; laser methods; data acquisition processing; electronics, instrument/computer interfacing; field methods of sampling and analysis. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.
- CH 920 SELECTED TOPICS IN ORGANIC CHEMISTRY**  
1-4 cr. (1-4 and 0) N  
Heterocyclic compounds; stereochemistry; natural products; organometallic chemistry; photochemistry. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.
- CH 930 SELECTED TOPICS IN PHYSICAL CHEMISTRY**  
1-4 cr. (1-4 and 0) N  
Special problems in molecular spectroscopy, molecular orbital treatments, applications of group theory to chemical structure, irreversible thermodynamics and special topics in statistical mechanics. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.
- CH 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged. F, S, SS

## Civil Engineering

Russell H. Brown, Chair, Department of Civil Engineering

**Major**  
Civil Engineering

**Degrees**  
M.Engr., M.S., Ph.D.

The Department of Civil Engineering offers programs of study in specialty areas of construction, structures, traffic and transportation, hydraulics, natural hazards and geotechnical engineering. A program also may encompass course work in several related interdisciplinary fields such as environmental systems engineering.

Two options are offered for the M.S. degree. The nonthesis option requires 30 hours of course work and a written and oral examination. The thesis option requires 30 hours of course work, six

of which are thesis research. All graduate students are required to complete C E 895 and an oral examination as a requirement for any graduate degree.

Excellent facilities for graduate work are available, and each student's educational and research program can be arranged to suit his or her personal and professional goals.

- C E 603 USE OF COMPUTERS IN STRUCTURAL ANALYSIS AND DESIGN**  
3 cr. (3 and 0)
- C E 604 MASONRY STRUCTURAL DESIGN**  
3 cr. (3 and 0)
- C E 605 STRUCTURAL SYSTEMS DESIGN**  
3 cr. (3 and 0)
- C E 610 TRAFFIC ENGINEERING OPERATIONS**  
3 cr. (3 and 0) S
- C E 612 URBAN TRANSPORTATION PLANNING**  
3 cr. (3 and 0) F
- C E 617 AIRPHOTO INTERPRETATION**  
3 cr. (2 and 3) S
- C E 630 GEOTECHNICAL ENGINEERING DESIGN**  
3 cr. (3 and 0)
- C E 632 CONSTRUCTION PROJECT ADMINISTRATION**  
3 cr. (3 and 0)
- C E 633 CONSTRUCTION PLANNING AND SCHEDULING**  
3 cr. (3 and 0)
- C E 634 CONSTRUCTION ESTIMATING AND PROJECT CONTROL**  
3 cr. (3 and 0)
- C E 638 CONSTRUCTION SUPPORT OPERATIONS**  
3 cr. (3 and 0)
- C E 639 CONSTRUCTION EQUIPMENT SELECTION AND MAINTENANCE**  
3 cr. (3 and 0)
- C E 646 FLOOD HAZARDS AND PROTECTIVE DESIGN**  
3 cr. (3 and 0)
- C E 653 STRUCTURAL ANALYSIS II**  
3 cr. (3 and 0)
- C E 662 COASTAL ENGINEERING I**  
3 cr. (3 and 0)
- C E 664 PHYSICAL MODELS IN FLUID MECHANICS**  
3 cr. (2 and 2)
- C E 680 WIND ENGINEERING**  
3 cr. (2 and 2)
- C E 682 (E S E 682) GROUNDWATER AND CONTAMINANT TRANSPORT**  
3 cr. (3 and 0) S
- CE 691 SELECTED TOPICS IN CIVIL ENGINEERING**  
1-6 cr. (1-6 and 0)



- C E 801 MATRIX AND FINITE ELEMENT ANALYSIS**  
3 cr. (3 and 0)  
Matrix and finite element methods in solution of engineering problems; stiffness matrices for triangular, rectangular and quadrilateral elements in planer systems; plate bending, shell and 3-D elements; applications to solutions of structural and soil mechanics problems using special and general purpose programs. **Prerequisite:** C E 453/653 or permission of instructor.
- C E 802 ADVANCED REINFORCED CONCRETE DESIGN**  
3 cr. (3 and 0)  
Second course in design of reinforced concrete structures; advanced concepts in analysis and design of beams, columns and slabs; introduction to prestressed concrete. **Prerequisite:** C E 402 or permission of instructor.
- C E 803 ADVANCED STEEL DESIGN**  
3 cr. (3 and 0)  
Advanced design of structural steel buildings emphasizing the relationship between design and response of the structural system; theoretical basis of building code provisions; limit state and plastic design; beam-columns; plate girders and composite sections and connections. **Prerequisite:** C E 302 or permission of instructor.
- C E 805 STRUCTURAL MECHANICS**  
3 cr. (3 and 0)  
Development and utilization of mechanics principles in solution of structural problems; unsymmetrical bending and curved beams; beams on elastic foundations; plastic structure analysis of beams and frames; eigenvalue problems; plastic stress-strain relations; strain energy; series and finite element solutions to plate and shell structures. **Prerequisite:** CE 453/653 or permission of instructor.
- C E 806 DYNAMIC ANALYSIS OF STRUCTURES**  
3 cr. (3 and 0)  
Analysis and design of structures subjected to dynamic loading; response of lumped and distributed parameter systems of one or many degrees of freedom; approximate design methods; introduction to earthquake analysis and design. **Prerequisite:** C E 801 or permission of instructor.
- C E 807 WIND ENGINEERING**  
3 cr. (2 and 2)  
Effects of wind on buildings, bridges and other structures; meteorological aspects of wind generation; types and characteristics of various wind events; aerodynamics of flow around structures; wind-induced loads; structural responses; design basis safety and serviceability criteria.
- C E 808 EARTHQUAKE ENGINEERING**  
3 cr. (3 and 0)  
Effects of earthquake-induced forces on buildings, bridges and other structures; development of design codes and their application to the design of structures to resist seismic forces; fundamental structural dynamics and analysis techniques used to compute the response of structures or obtain design forces. **Prerequisite:** CE 806 or permission of instructor.
- C E 809 FORENSIC ENGINEERING**  
3 cr. (3 and 0)  
Civil engineering failures including an analysis of conditions just prior to the failure, load or event causing failure, methods of investigation and design of remedial measures; case histories of failures illustrating common errors and failures; student projects involve design of remedial measures and alternatives.
- C E 811 HIGHWAY GEOMETRIC DESIGN**  
3 cr. (2 and 3)  
Geometric design of roadways, at-grade intersections and interchanges in accordance with conditions imposed by driver ability, vehicle performance, safety and economics. **Prerequisite:** C E 410/610.
- C E 813 HIGHWAY AND AIRPORT PAVEMENT DESIGN**  
3 cr. (3 and 0)  
Structural design of rigid and flexible pavements; design of bases and subbases; theory of stresses and application of plate bearing, triaxial and California Bearing Ratio design methods to flexible pavements; Westergaard analysis for rigid pavements; pavement evaluation methods. **Prerequisite:** C E 330.
- C E 815 TRANSPORTATION SAFETY ENGINEERING**  
3 cr. (3 and 0)  
Methodology for conducting transportation accident studies; accident characteristics as related to operator, facility and mode; statistical applications to accident data; current trends and problems in transportation safety. **Prerequisite:** C E 310.
- C E 816 HIGHWAY PLANNING**  
3 cr. (3 and 0)  
Various aspects of highway planning: planning surveys, needs studies, impact studies, sufficiency ratings, highway finance, highway administration, and extensive treatment of economic evaluation of alternative highway projects by benefit cost ratio, annual cost, rate of return and investment return procedures.
- C E 817 MASS TRANSIT PLANNING**  
3 cr. (3 and 0)  
Mass transit planning; characteristics of modern mass transit systems; case studies of mass transit in selected cities; transit studies; marketing and financing mass transit; recent innovation in mass transit; current issues in mass transit planning; future developments in mass transit.
- C E 818 AIRPORT PLANNING AND DESIGN**  
3 cr. (3 and 0)  
Planning and design of airports and other air transportation facilities; characteristics of air transport; future role of air transport in overall transportation program.



- C E 819 TRANSPORTATION RESEARCH**  
2-4 cr.  
Independent investigation of problems in transportation engineering.
- C E 823 ASPHALT CONCRETE PROPERTIES**  
3 cr. (3 and 0)  
Identification and suitability of aggregates for construction; characteristics and properties of bituminous materials; materials behavior, construction and design problems; some use of microcomputers and the mainframe. **Prerequisite:** C E 320 or equivalent.
- C E 830 ADVANCED SOIL MECHANICS**  
3 cr. (3 and 0)  
Stresses in soils; plastic equilibrium of soil masses; failure conditions; earth pressures; analysis of flexible retaining wall bulkheads; solution of problem by elastic theory. **Prerequisite:** C E 330.
- C E 831 FOUNDATION ENGINEERING**  
3 cr. (3 and 0)  
Requirements for satisfactory foundations; theory and design of shallow foundations; pressure distribution beneath rigid and flexible shallow foundations; bearing capacity and settlement of deep foundations; foundation failures. **Prerequisite:** C E 830 or permission of instructor.
- C E 833 ANALYSIS AND DESIGN OF DEEP FOUNDATIONS**  
3 cr. (3 and 0)  
Methods for predicting bearing capacity and settlement of single piles, pile groups and drilled shafts; analysis and design of pile and pier foundations for resisting axial, lateral and uplifting loads; load test interpretation and evaluation. **Prerequisite:** C E 830 or permission of instructor.
- C E 835 CONSTRUCTION PROJECT MODELING**  
3 cr. (3 and 0)  
Mathematical and computer models to simulate construction operations; linear models and optimization applications to construction materials, scheduling and equipment allocation; typical computer models used in construction; simple modeling examples. **Prerequisite:** C E 324 or permission of instructor.
- C E 836 CIVIL ENGINEERING QUALITY MANAGEMENT**  
3 cr. (3 and 0)  
Principles of total quality management (TQM) and their applications in the engineering and construction industry; TQM implementation techniques, with particular emphasis on the construction environment; concepts of quality assurance (QA) and quality control (QC) in construction. **Prerequisite:** Permission of instructor.
- C E 837 CONSTRUCTION SPECIFICATIONS AND CONTRACTS**  
3 cr. (3 and 0)  
Elements of specifications delineating responsibilities of all involved parties and identifying courses of action during abnormal circumstances; necessary parts of a contract dealing with governmental regulations and institutional preferences, licenses, bonds, insurance and taxes. **Prerequisite:** C E 324 or equivalent.
- C E 838 MATERIALS MANAGEMENT**  
3 cr. (3 and 0)  
Functions of construction materials management, including design interface, purchasing, expediting, transportation, field control and warehousing; design and application of integrated materials management computer systems; new technology that impacts materials management, including bar coding, electronic data interchange and voice recognition. **Prerequisite:** Permission of instructor.
- C E 839 EXPERT SYSTEMS APPLICATIONS IN CIVIL ENGINEERING**  
3 cr. (3 and 0)  
Applications of expert systems in civil engineering design, construction and facility management; use of expert systems shells for expert systems development; linking expert systems to external programs; knowledge acquisition and system validation.
- C E 840 PROJECT MANAGEMENT APPLICATIONS**  
3 cr. (3 and 0)  
Quantitative tools for effective management and control of engineered projects from design through construction; cost coding and control, advanced schedule management techniques and quality management principles; extensive hands-on use of the microcomputer. **Prerequisites:** C E 433 and 434 or equivalent.
- C E 846 FLOW IN OPEN CHANNELS**  
3 cr. (3 and 0)  
Free surface flow problems; applications of digital computer; concepts of boundary layer theory; uniform and varied flow; hydraulic jump; design criteria for prismatic channels and transitions; some applications of unsteady flow. **Prerequisites:** Graduate standing and permission of instructor.
- C E 850 ADVANCED ANALYSIS TECHNIQUES IN CIVIL ENGINEERING**  
3 cr. (3 and 0)  
Analytical and numerical methods in the solution of engineering problems; analysis tools developed and demonstrated through the study and solution of various civil engineering problems; analysis tools include closed form solutions, numeric integration and differentiation, eigenvalues and eigenvectors, finite difference solutions and series solutions.
- C E 851 RELIABILITY ANALYSIS AND DESIGN IN CIVIL ENGINEERING**  
3 cr. (3 and 0)  
Elements of probabilistic methods; classical theory of structural reliability and reliability-based design methods; term project required on reliability design in a relevant field of civil engineering. **Prerequisite:** Permission of instructor.



- C E 852 (E M 852) ADVANCED FINITE ELEMENT ANALYSIS**  
3 cr. (3 and 0)  
See E M 852 for description.
- C E 860 ADVANCED FLUID MECHANICS**  
3 cr. (3 and 0)  
Laminar and turbulent flows; boundary layer and free shear flows (jets, wakes, etc.); descriptions of velocity, shear stress and pressure measurements, and aerodynamic drag.
- C E 861 MECHANICS OF SEDIMENT TRANSPORT**  
3 cr. (3 and 0)  
Characterization of sediments; physical principles governing fluvial, estuarial and coastal transport of cohesionless and cohesive sediments, including incipient motion, stable channel design, bedforms, and bedload and suspended transport. **Prerequisite:** C E 422 or equivalent.
- C E 863 COASTAL ENGINEERING II**  
3 cr. (3 and 0)  
Littoral processes; coastal structures; port engineering; estuarial hydromechanics; littoral transport; port and harbor design; functional design of coastal structures; tidal dynamics in estuaries. **Prerequisite:** C E 462/662.
- C E 865 HYDROLOGIC SYSTEMS ANALYSIS**  
3 cr. (3 and 0)  
Hydrologic cycle as a hydrologic system; deterministic hydrology; all aspects of physical hydrology emphasizing balanced approach to groundwater hydrology and surface water hydrology; infiltration; soil moisture and evapotranspiration; probability analysis and system synthesis by convolution. **Prerequisite:** Permission of instructor.
- C E 875 NUMERICAL MODELS IN HYDRAULICS**  
3 cr. (3 and 0)  
Finite difference and finite element methods used to solve hydraulic engineering problems; class assignments include the development of a finite difference model and the use of an existing finite element model to solve problems in coastal engineering and river mechanics. **Prerequisite:** C E 422.
- C E 889 SPECIAL PROBLEMS I**  
1-3 cr.  
Research design problems from field of structures, construction, soil mechanics, transportation, ocean and coastal engineering, or materials engineering; subject matter varies with interest and experience of student and instructor.
- C E 890 SPECIAL PROBLEMS II**  
1-3 cr.  
Research design problems from field of structures, construction, soil mechanics, transportation, ocean and coastal engineering, or materials engineering; subject matter varies with interest and experience of student and instructor.
- C E 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.

- C E 893 SELECTED TOPICS IN CIVIL ENGINEERING**  
1-6 cr. (1-6 and 1-6)  
Topics not covered in other courses. May be repeated for credit.
- C E 895 CIVIL ENGINEERING SEMINAR**  
1 cr. (0 and 2)  
Current and historic topics in various areas of civil engineering; speakers may include off-campus experts, faculty and graduate students; presentation of at least one seminar is required.
- C E 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

### Computer Engineering

Kelvin F. Poole, Chair, Department of Electrical and Computer Engineering

Major	Degrees
Computer Engineering	M.S., Ph.D.

The computer engineering program is a combination of computer software, hardware, systems and applications. Focus areas include computer systems architecture, computer communications and artificial intelligence. Enrollment is open to graduates in any branch of engineering, computer science or applied mathematics who have an appropriate engineering and/or science background.

For the M.S. program, students may write a thesis or follow a nonthesis option. The thesis option requires a total of 30 credit hours including six hours of thesis research. For the nonthesis option, 33 credit hours of course work must be completed.

Specially qualified candidates with a B.S. degree may apply for direct entry to the Ph.D. program in any of the above areas. The program of study and hours required beyond the baccalaureate degree are specified by the focus area, but must be at least 66 including course work and research credit.

- E C E 606 INTRODUCTION TO MICROELECTRONICS PROCESSING**  
3 cr. (3 and 0) S
- E C E 607 VLSI RELIABILITY**  
3 cr. (3 and 0) S
- E C E 617 ELEMENTS OF SOFTWARE ENGINEERING**  
3 cr. (3 and 0) F, S
- E C E 618 POWER SYSTEM ANALYSIS**  
3 cr. (3 and 0) F
- E C E 619 ELECTRIC MACHINERY**  
3 cr. (3 and 0) S
- E C E 622 OPERATIONAL AMPLIFIER CIRCUITS**  
3 cr. (2 and 2) S
- E C E 623 POWER SYSTEM PROTECTION**  
3 cr. (3 and 0) S
- E C E 626 DIGITAL COMPUTER DESIGN**  
3 cr. (3 and 0) F, S
- E C E 629 ORGANIZATION OF COMPUTERS**  
3 cr. (3 and 0) F, S
- E C E 631 DIGITAL ELECTRONICS**  
3 cr. (2 and 2) F, S



<b>E C E 633</b>	<b>SENSORS AND MICROCOMPUTER CONTROL FOR ROBOTS</b> 3 cr. (1 and 4) F
<b>E C E 636</b>	<b>TRANSMISSION LINES AND MICROWAVE CIRCUITS</b> 3 cr. (3 and 0) F
<b>E C E 638</b>	<b>COMPUTER COMMUNICATIONS</b> 3 cr. (3 and 0) F
<b>E C E 639</b>	<b>FIBER OPTICS</b> 3 cr. (3 and 0) F
<b>E C E 640</b>	<b>PERFORMANCE ANALYSIS OF LOCAL COMPUTER NETWORKS</b> 3 cr. (3 and 0) S
<b>E C E 642</b>	<b>KNOWLEDGE ENGINEERING</b> 3 cr. (3 and 0) F
<b>E C E 646</b>	<b>ANTENNAS AND PROPAGATION</b> 3 cr. (3 and 0) S
<b>E C E 652</b>	<b>PROGRAMMING SYSTEMS</b> 3 cr. (3 and 0) S
<b>E C E 653</b>	<b>SOFTWARE PRACTICUM</b> 3 cr. (1 and 6)
<b>E C E 660</b>	<b>COMPUTER-AIDED ANALYSIS AND DESIGN</b> 3 cr. (3 and 0) F
<b>E C E 667</b>	<b>INTRODUCTION TO DIGITAL SIGNAL PROCESSING</b> 3 cr. (3 and 0) F, S
<b>E C E 668</b>	<b>THE EMBEDDED MICROPROCESSOR</b> 3 cr. (2 and 2) S
<b>E C E 692</b>	<b>SPECIAL PROBLEMS</b> 1-3 cr. (0 and 2)
<b>E C E 693</b>	<b>SELECTED TOPICS</b> 1-3 cr. (1-3 and 0)
<b>E C E 801</b>	<b>ANALYSIS OF LINEAR SYSTEMS*</b> 3 cr. (3 and 0) F
<b>E C E 802</b>	<b>ELECTRIC MOTOR CONTROL*</b> 3 cr. (3 and 0)
<b>E C E 811</b>	<b>INTEGRATED CIRCUIT DESIGN</b> 3 cr. (2 and 2) Design concepts and factors influencing the choice of technology; fundamental MOS device design; silicon foundries; custom and semi-custom integrated circuits; computer-aided design software/hardware trends and future developments; the hands-on use of CAD tools to design MOS standard cells; systems design, testing and packaging. <b>Prerequisite:</b> E C E 459/659.
<b>E C E 818</b>	<b>RANDOM PROCESS APPLICATIONS IN ENGINEERING</b> 3 cr. (3 and 0) Theory of random processes emphasizing engi-

neering applications; stochastic convergence and limit theories; martingales; mean-square calculus; Karhunen-Loeve expansions; systems with stochastic inputs; Poisson processes; shot noise; Weiner processes; white noise processes; Markov systems; queuing systems; and estimate theory. **Prerequisites:** E C E 317 and 330 or permission of instructor.

<b>E C E 838</b>	<b>SPECIAL TOPICS IN ELECTROMAGNETICS*</b> 1 cr. (1 and 0)
<b>E C E 839</b>	<b>INTEGRAL EQUATIONS IN ELECTROMAGNETICS*</b> 3 cr. (3 and 0)
<b>E C E 841</b>	<b>DISTRIBUTED COMPUTING AND NETWORKS</b> 3 cr. (3 and 0) S Design oriented toward distributed computing and computing concepts; design issues; implementation techniques; communication networks; analytical tools for system evaluation; data transmission principles; data concentration. <b>Prerequisite:</b> E C E 438/638.
<b>E C E 842</b>	<b>COMPUTER ARCHITECTURE</b> 3 cr. (3 and 0) S Fundamental issues that arise in the composition of logic elements into computer systems; design and analysis of processors, busses, memory hierarchies, communications controllers and associated software. <b>Prerequisite:</b> E C E 429 or equivalent.
<b>E C E 844</b>	<b>DIGITAL SIGNAL PROCESSING*</b> 3 cr. (3 and 0)
<b>E C E 845</b>	<b>COMPUTER SYSTEM DESIGN AND OPERATION</b> 3 cr. (3 and 0) Factors involved in design, acquisition and operation of a computer system; analysis methods; alternative computer systems; computer economics; performance evaluation; operational requirements. <b>Prerequisite:</b> Permission of instructor.
<b>E C E 846</b>	<b>DIGITAL PROCESSING OF SPEECH SIGNALS*</b> 3 cr. (3 and 0)
<b>E C E 847</b>	<b>DIGITAL IMAGE PROCESSING*</b> 3 cr. (3 and 0)
<b>E C E 848</b>	<b>TELECOMMUNICATION NETWORK MODELING AND ANALYSIS</b> 3 cr. (3 and 0) Protocols, modeling and analysis of telecommunication networks, with emphasis on quantitative performance modeling of networks and systems using packet switching and circuit switching techniques. <b>Prerequisite:</b> E C E 438/638 or CP SC 825.
<b>E C E 849</b>	<b>ADVANCED TOPICS IN COMPUTER COMMUNICATIONS</b> 3 cr. (3 and 0) Performance analysis and design of computer

\* Descriptions of these courses are listed under Electrical Engineering.



communication networks with emphasis on recent developments. Topics include such issues as routing flow control, error control and end-to-end performance analysis, local area, packet radio and long haul store-and-forward networks. **Prerequisites:** E C E 438/638 or 440/640, and permission of instructor.

- E C E 850 COMPUTATION AND SIMULATION**  
3 cr. (3 and 0)  
Computer modeling as related to engineering problems; matching problems and computers to obtain most effective solution.
- E C E 851 ADVANCED TOPICS IN COMPUTER ARCHITECTURE**  
3 cr. (3 and 0)  
Analysis and design of multiprocessor and modular computer systems; recent developments in integration, fabrication and application of multiprocessor systems. **Prerequisite:** E C E 842.
- E C E 852 SOFTWARE ENGINEERING**  
3 cr. (3 and 0) F  
Design, construction verification and testing of large-scale computer software systems. Topics include software science, requirements writing, design graphics, the calculus of programs, verification proofs and symbolic execution. **Prerequisite:** Computer engineering major or permission of instructor.
- E C E 855 ARTIFICIAL INTELLIGENCE**  
3 cr. (3 and 0)  
Emulating intelligent behavior by computer; models of cognitive processes; logical foundations; constraint satisfaction problems; natural language understanding; pattern-directed inference and chaining paradigms; goal-directed behavior, planning and search; learning; advanced data base structure and inference strategies; examples of LISP, PROLOG and OPS5. **Prerequisite:** E C E 442/642.
- E C E 856 PATTERN RECOGNITION\***  
3 cr. (3 and 0)
- E C E 872 ARTIFICIAL NEURAL NETWORKS**  
3 cr. (3 and 0)  
Design, analysis and application of artificial neural networks. Topics include neuron models, network architectures, training (supervised and unsupervised) and hardware implementation; extended studies of selected applications and simulation exercises. **Prerequisites:** MTHSC 311 or permission of instructor, and graduate standing.
- E C E 890 ENGINEERING REPORT RESEARCH**  
Variable credit hours.  
Research culminating in writing an engineering report to satisfy one of the requirements for the nonthesis option for the Master of Science degree; the engineering report is similar to the thesis but requires only departmental approval. Graded on a pass/fail basis.

- E C E 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- E C E 892 SPECIAL PROBLEMS IN ELECTRICAL AND COMPUTER ENGINEERING**  
1-3 cr. (1-3 and 0)  
Term paper, special design or other problems in electrical and computer engineering approved by the instructor; not to be used for investigation associated with the M.S. thesis or the engineering report. May be repeated for additional credit.
- E C E 893 SELECTED TOPICS IN ELECTRICAL AND COMPUTER ENGINEERING**  
1-3 cr. (1-3 and 0)  
Topics not covered in other courses; current literature and results of current research. Topics vary from year to year in keeping with developments in the field; may be repeated for additional credit. **Prerequisite:** Permission of instructor.
- E C E 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

### Computer Science

Stephen T. Hedetniemi, Chair, Department of Computer Science

Major	Degrees
Computer Science	M.S., Ph.D.

The following are required for unconditional admission to graduate study in computer science:

1. intermediate-level undergraduate computer science, including computer organization and data representation, machine and assembly language programming, data structures, file organization and processing, programming systems, theory of computation and software methodology; and
2. basic mathematics, including calculus, probability and statistics, and discrete mathematics.

An applicant with minimal deficiencies may be admitted provisionally, while one with several deficiencies may be required to complete satisfactorily prerequisite work as a postbaccalaureate student prior to admission as a graduate student.

A candidate for the M.S. degree must complete satisfactorily an approved program of at least 30 graduate hours. There are three options available to the student to satisfy the degree requirements. Option 1 requires course work only, followed by a written examination. Option 2 requires a research paper, and Option 3 requires a thesis. Students may take up to six hours of approved courses in areas outside the department.

Although formal course requirements for the Ph.D. degree are minimal, a typical program requires two to four years of effort beyond the M.S. degree. Each candidate is required to pass a qualifying examination, a comprehensive examination, a dissertation proposal and a defense of the dissertation.

- CP SC 605 INTRODUCTION TO GRAPHICAL SYSTEMS DESIGN**  
3 cr. (3 and 0) F
- CP SC 622 INTRODUCTION TO OPERATING SYSTEMS**  
3 cr. (3 and 0)
- CP SC 623 IMPLEMENTATION OF OPERATING SYSTEMS**  
3 cr. (2 and 2)

\* Description of this course is listed under Electrical Engineering.



- CP SC 628 DESIGN AND IMPLEMENTATION OF PROGRAMMING LANGUAGES**  
3 cr. (3 and 0)
- CP SC 629 TRANSLATION OF PROGRAMMING LANGUAGES**  
3 cr. (3 and 0)
- CP SC 650 THEORY OF COMPUTATION**  
3 cr. (3 and 0)
- CP SC 662 DATA BASE MANAGEMENT SYSTEMS**  
3 cr. (3 and 0)
- CP SC 663 ON-LINE SYSTEMS**  
3 cr. (3 and 0)
- CP SC 664 INTRODUCTION TO COMPUTER ARCHITECTURE**  
3 cr. (3 and 0)
- CP SC 672 SOFTWARE DEVELOPMENT METHODOLOGY**  
3 cr. (3 and 0)
- CP SC 681 SELECTED TOPICS**  
1-3 cr. (1-3 and 0)
- CP SC 740 COMPUTER SCIENCE FOR HIGH SCHOOL TEACHERS I**  
3 cr. (2 and 2) N  
Introduction to modern problem-solving and programming methods for high school teachers. Topics include algorithm development, software life cycle concepts, system hardware and software components, and an introduction to programming in PASCAL. Restricted to graduate students and in-service teachers in secondary education. **Prerequisite:** Introductory computer programming.
- CP SC 741 COMPUTER SCIENCE FOR HIGH SCHOOL TEACHERS II**  
3 cr. (2 and 2) N  
Continuation of CP SC 740; problem-solving and programming techniques are considered in greater depth; elementary data structures are introduced. Restricted to graduate students and in-service teachers in secondary education. **Prerequisite:** CP SC 740 or equivalent.
- CP SC 805 ADVANCED MODELING TECHNIQUES IN COMPUTER GRAPHICS**  
3 cr. (3 and 0) S  
In-depth treatment of advanced techniques used in the artificial rendering of natural scenes; brings students to the frontier of current practice in computer graphics; full software implementation of each technique is carried out; extensive coding is required. **Prerequisite:** CP SC 405/605.
- CP SC 810 INTRODUCTION TO ARTIFICIAL INTELLIGENCE**  
3 cr. (3 and 0) S  
Problem solving and game playing; knowledge representation; expert systems; natural language processing; perception and learning. **Prerequisite:** Permission of instructor.

- CP SC 820 PARALLEL ARCHITECTURE**  
3 cr. (3 and 0) S  
Parallel processing issues; vector and pipeline processors; arrays of processing elements; associative processors; data flow computers; networks of processors; survey of parallel programming languages; design and implementation of parallel algorithms; future trends. **Prerequisite:** CP SC 664.
- CP SC 822 CASE STUDY IN OPERATING SYSTEMS**  
3 cr. (2 and 2)  
Case study of the design of an operating system. Class periods are devoted to reviewing source code and deducing the structure of the system. Lab exercises require students to make major changes to the system to enhance its performance on particular workloads. **Prerequisites:** CP SC 422/622 and permission of departmental graduate affairs chairperson.
- CP SC 823 OPERATING SYSTEMS DESIGN**  
3 cr. (3 and 0) F  
Analytic, simulation and conceptual models of operating systems and their application to the design and implementation of actual systems; kernel design and its implementation in UNIX-like systems; models of concurrent processes, processor scheduling and memory management. **Prerequisites:** MTHSC 401/601 and CP SC 423/623.
- CP SC 824 ADVANCED OPERATING SYSTEMS**  
3 cr. (3 and 0) S  
Recent trends in system design and implementation; operating system structures to support reliable secure systems; verification techniques; fault tolerant systems; operating system considerations for closely coupled multiprocessor systems; network operating systems. **Prerequisite:** CP SC 623 or permission of instructor.
- CP SC 825 SOFTWARE SYSTEMS FOR DATA COMMUNICATIONS**  
3 cr. (3 and 0) F  
Structure of software systems supporting communications among computing devices having diverse processing and communication capabilities; characterization of data communications software in terms of unified network architectures consisting of several functional layers; evaluation of several network architectures. **Prerequisite:** CP SC 622 or permission of instructor.
- CP SC 828 THEORY OF PROGRAMMING LANGUAGES**  
3 cr. (3 and 0) F  
Syntax and semantics of programming languages; finite state and pushdown processors; context-free models of syntax; parsing algorithms and semantic models. **Prerequisites:** CP SC 429/629 and 450/650.
- CP SC 829 ADVANCED COMPILER TOPICS**  
3 cr. (3 and 0) S  
Advanced study of code generation, register allocation, program optimization, data flow, interprocedural operations, parallel compilation and distributed compilation. **Prerequisites:** CP SC 429/629 and 450/650.



- CP SC 830 SYSTEMS MODELING**  
3 cr. (3 and 0) S (even numbered years)  
Fundamental concepts and techniques used in the stochastic modeling of computer and computer-based communication systems; applications include hardware configuration design, software performance evaluation and reliability estimation of fault-tolerant systems. **Prerequisites:** CP SC 630 and MTHSC 400 or MTHSC 800, or permission of instructor.
- CP SC 838 ADVANCED DATA STRUCTURES**  
3 cr. (3 and 0) F (odd numbered years)  
Search trees; data structures for sets; index structures for data bases; data abstraction and automated implementation; implicit data structures; storage compaction of lists; data structures for decision trees; data structures in areas such as computer graphics, artificial intelligence, picture processing and simulation. **Prerequisite:** Permission of instructor.
- CP SC 840 DESIGN AND ANALYSIS OF ALGORITHMS**  
3 cr. (3 and 0) S  
Basic techniques for design and analysis of algorithms; models and techniques for obtaining upper and lower time and space bounds; time/space trade-offs; inherently difficult problems. **Prerequisite:** MTHSC 419/619 or CP SC 650 or equivalent.
- CP SC 841 COMPUTATIONAL COMPLEXITY**  
3 cr. (3 and 0) F (even numbered years)  
Deterministic and nondeterministic polynomial-time algorithms; NP-complete problems and Cook's Theorem; techniques for establishing NP-completeness; oracle machines; polynomial-time hierarchy; polynomial space; probabilistic algorithms and complexity classes; parallel complexity; provable intractability results. **Prerequisite:** CP SC 650 or 840.
- CP SC 850 RECURSIVE FUNCTION THEORY**  
3 cr. (3 and 0) S (even numbered years)  
Turing machines; partially computable functions; r.e. sets; reducibilities; complete sets; recursion theorem; arithmetic hierarchy; Post's Theorem; priority methods; Turing degrees. **Prerequisite:** CP SC 650.
- CP SC 859 FOUNDATIONS OF THEORETICAL COMPUTER SCIENCE**  
3 cr. (3 and 0)  
Preparation for the study of advanced issues in computational complexity, algorithm correctness and inherent limits to computing; set theory and proof techniques; classes of the Chomsky hierarchy. **Prerequisite:** CP SC 350 or permission of the department chair.
- CP SC 862 DATA BASE MANAGEMENT SYSTEM DESIGN**  
3 cr. (3 and 0) S  
Concepts and structures for design and implementation of a DBMS; theoretical foundations for query systems; data modeling and information representation; user interface and internal system design considerations; system performance modeling and measurement; topics from the literature. **Prerequisite:** CP SC 462.
- CP SC 864 COMPUTER ARCHITECTURE**  
3 cr. (3 and 0) F  
Computer architecture and structures from the classical Von Neumann machines to state-of-the-art computer organizations; nonconventional architectures such as array, pipeline, associative, data flow, reduction and tree machines. **Prerequisite:** CP SC 664.
- CP SC 872 SOFTWARE SPECIFICATION AND DESIGN TECHNIQUES**  
3 cr. (3 and 0) F  
Techniques, tools, environments and formal methods for software specification and design; verification of design correctness. **Prerequisite:** CP SC 672 or equivalent.
- CP SC 873 SOFTWARE VERIFICATION, VALIDATION AND MEASUREMENT**  
3 cr. (3 and 0) S  
Proofs of correctness; test planning; static and dynamic testing; symbolic execution; automated testing; verification and validation over the software life cycle; software metrics; software maintenance. **Prerequisite:** CP SC 672 or equivalent.
- CP SC 881 SELECTED TOPICS**  
1-3 cr. (1-3 and 0)  
Advanced topics from current problems of interest in computer science. Topics vary from semester to semester. May be repeated for credit, but only if different topics are covered. **Prerequisite:** Permission of instructor.
- CP SC 888 DIRECTED PROJECTS IN COMPUTER SCIENCE**  
1-6 cr.  
Directed individual project supervised by department faculty. Graded on a pass/fail basis.
- CP SC 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- CP SC 951 SEMINAR IN ALGORITHMS**  
1-3 cr. (1-3 and 0) N  
Advanced topics from current problems of interest in algorithms. May be repeated for credit. **Prerequisite:** Graduate status.
- CP SC 952 SEMINAR IN COMPUTER ARCHITECTURE**  
1-3 cr. (1-3 and 0) N  
Advanced topics from current problems of interest in computer architecture. May be repeated for credit. **Prerequisite:** Graduate status.
- CP SC 953 SEMINAR IN DATABASE SYSTEMS**  
1-3 cr. (1-3 and 0) N  
Advanced topics from current problems of interest in database systems. May be repeated for credit.
- CP SC 954 SEMINAR IN OPERATING SYSTEMS**  
1-3 cr. (1-3 and 0) N  
Advanced topics from current problems of interest in operating systems. May be repeated for credit. **Prerequisite:** Graduate status.



<b>CP SC 955</b>	<b>SEMINAR IN PROGRAMMING LANGUAGES</b> 1-3 cr. (1-3 and 0) N Advanced topics from current problems of interest in programming languages. May be repeated for credit. <b>Prerequisite:</b> Graduate status.
<b>CP SC 956</b>	<b>SEMINAR IN PROGRAMMING PARADIGMS</b> 1-3 cr. (1-3 and 0) N Advanced topics from current problems of interest in programming paradigms. May be repeated for credit. <b>Prerequisite:</b> Graduate status.
<b>CP SC 957</b>	<b>SEMINAR IN SOFTWARE ENGINEERING</b> 1-3 cr. (1-3 and 0) N Advanced topics from current problems of interest in software engineering. May be repeated for credit. <b>Prerequisite:</b> Graduate status.
<b>CP SC 981</b>	<b>SEMINAR IN COMPUTER SCIENCE</b> 1-3 cr. (1-3 and 0) N Topics of current research interest. May be repeated for credit.
<b>CP SC 991</b>	<b>DOCTORAL DISSERTATION RESEARCH</b> Credit to be arranged.

### Electrical Engineering

Kelvin F. Poole, Chair, Department of Electrical and Computer Engineering

#### Major

Electrical Engineering

#### Degrees

M.Engr., M.S., Ph.D.

Students in electrical engineering may direct their programs toward the fields of communications/digital signal process (digital communication, digital signal processing or image processing/artificial intelligence/pattern recognition); computer communications; controls/robotics; computational electromagnetics; electronics; and power systems.

For the M.S. program, students may write a thesis or follow a nonthesis option. The thesis option requires a total of 30 credit hours including six hours of thesis research. For the nonthesis option, 33 credit hours of course work must be completed. The M.Engr. program has the same requirements as the M.S. thesis option, but the thesis is replaced by an engineering report.

Specially qualified candidates with a B.S. degree may apply for direct entry to the Ph.D. program in any of the above areas. The program of study and hours required beyond the baccalaureate degree are specified by the focus area, but must be at least 66 including course work and research credit.

<b>E C E 604</b>	<b>SEMICONDUCTOR DEVICES</b> 3 cr. (3 and 0) F
<b>E C E 606</b>	<b>INTRODUCTION TO MICROELECTRONICS PROCESSING</b> 3 cr. (3 and 0) S
<b>E C E 607</b>	<b>VLSI RELIABILITY</b> 3 cr. (3 and 0) S
<b>E C E 610</b>	<b>MODERN CONTROL THEORY</b> 3 cr. (3 and 0) F, S
<b>E C E 616</b>	<b>ELECTRIC POWER DISTRIBUTION SYSTEM ENGINEERING</b> 3 cr. (3 and 0) S
<b>E C E 617</b>	<b>ELEMENTS OF SOFTWARE ENGINEERING</b> 3 cr. (3 and 0) F, S

<b>E C E 618</b>	<b>POWER SYSTEM ANALYSIS</b> 3 cr. (3 and 0) F
<b>E C E 619</b>	<b>ELECTRIC MACHINERY</b> 3 cr. (3 and 0) S
<b>E C E 622</b>	<b>OPERATIONAL AMPLIFIER CIRCUITS</b> 3 cr. (2 and 2) S
<b>E C E 623</b>	<b>POWER SYSTEM PROTECTION</b> 3 cr. (3 and 0) S
<b>E C E 626</b>	<b>DIGITAL COMPUTER DESIGN</b> 3 cr. (3 and 0) F, S
<b>E C E 628</b>	<b>MODULATION AND NOISE</b> 3 cr. (3 and 0) F
<b>E C E 629</b>	<b>ORGANIZATION OF COMPUTERS</b> 3 cr. (3 and 0) F, S
<b>E C E 630</b>	<b>INTRODUCTION TO DIGITAL COMMUNICATIONS</b> 3 cr. (3 and 0) S
<b>E C E 631</b>	<b>DIGITAL ELECTRONICS</b> 3 cr. (2 and 2) F, S
<b>E C E 632</b>	<b>INSTRUMENTATION</b> 3 cr. (3 and 0) F
<b>E C E 633</b>	<b>SENSORS AND MICROCOMPUTER CONTROL FOR ROBOTS</b> 3 cr. (1 and 4) F
<b>E C E 634</b>	<b>POWER ELECTRONICS</b> 3 cr. (3 and 0) F
<b>E C E 636</b>	<b>TRANSMISSION LINES AND MICROWAVE CIRCUITS</b> 3 cr. (3 and 0) F
<b>E C E 638</b>	<b>COMPUTER COMMUNICATIONS</b> 3 cr. (3 and 0) F
<b>E C E 639</b>	<b>FIBER OPTICS</b> 3 cr. (3 and 0) F
<b>E C E 640</b>	<b>PERFORMANCE ANALYSIS OF LOCAL COMPUTER NETWORKS</b> 3 cr. (3 and 0) S
<b>E C E 642</b>	<b>KNOWLEDGE ENGINEERING</b> 3 cr. (3 and 0) F
<b>E C E 646</b>	<b>ANTENNAS AND PROPAGATION</b> 3 cr. (3 and 0) S
<b>E C E 652</b>	<b>PROGRAMMING SYSTEMS</b> 3 cr. (3 and 0) S
<b>E C E 656</b> <b>(M E 656)</b>	<b>FUNDAMENTALS OF ROBOTICS</b> 3 cr. (3 and 0)
<b>E C E 659</b>	<b>INTEGRATED CIRCUIT DESIGN</b> 3 cr. (2 and 2) F, S
<b>E C E 660</b>	<b>COMPUTER-AIDED ANALYSIS AND DESIGN</b> 3 cr. (3 and 0) F



- E C E 667 INTRODUCTION TO DIGITAL SIGNAL PROCESSING**  
3 cr. (3 and 0) F, S
- E C E 668 THE EMBEDDED MICROPROCESSOR**  
3 cr. (2 and 2) S
- E C E 692 SPECIAL PROBLEMS**  
1-3 cr. (0 and 2)
- E C E 693 SELECTED TOPICS**  
1-3 cr. (1-3 and 0)
- E C E 701 MASTER OF ENGINEERING DESIGN PROJECT**  
1-6 cr. (0 and 0) F, S  
Practical problems in engineering analysis and design, culminating in the written report required for the Master of Engineering (M.Engr.) degree. Graded on a pass/fail basis. May be repeated for up to six hours total credit.
- E C E 801 ANALYSIS OF LINEAR SYSTEMS**  
3 cr. (3 and 0) F  
Foundations of linear system analysis; matrix algebra, linear graph theory and operational mathematics applied to formulation and solution of system equations in time and frequency domains.
- E C E 802 ELECTRIC MOTOR CONTROL**  
3 cr. (3 and 0)  
Dynamic modeling and analysis of electrical machines for design of AC and DC drive systems; emphasis on implementation of such models on a digital computer; voltage-fed inverters; pulse width modulation and analysis techniques for inverters; harmonic generation and reduction. **Prerequisite:** E C E 434/634.
- E C E 804 METHODS OF APPLIED OPTIMIZATION AND OPTIMUM CONTROL**  
3 cr. (3 and 0)  
Methods of optimizing systems with and without dynamics, including linear programming, nonlinear programming, integer programming, gradient and variational calculus, minimum principle, principle of optimality and dynamic programming. **Corequisite:** MTHSC 653.
- E C E 805 METHODS OF STATE AND PARAMETER ESTIMATION OF STOCHASTIC SYSTEMS**  
3 cr. (3 and 0)  
State and parameter estimations of both linear and nonlinear continuous-time and discrete-time systems, including model identification: Kalman and Wiener filters, fixed-interval, fixed-point and fixed-lag smoothers, stochastic approximation estimation, nonlinear estimation by statistical linearization and sensitivity analysis of Kalman filters. **Corequisite:** MTHSC 654.
- E C E 807 COMPUTER METHODS FOR POWER SYSTEMS ANALYSIS**  
3 cr. (3 and 0)  
Electric power system operation; development of models of transmission line components and networks; computer methods for solving linear and nonlinear systems of network equations; operating problems in load flow, scheduling and economic dispatch. **Prerequisite:** E C E 418/618.
- E C E 811 INTEGRATED CIRCUIT DESIGN**  
3 cr. (2 and 2)  
Design concepts and factors influencing the choice of technology; fundamental MOS device design; silicon foundries, custom and semi-custom integrated circuits; computer-aided design software/hardware trends and future developments; the hands-on use of CAD tools to design MOS standard cells; systems design, testing and packaging. **Prerequisite:** E C E 459/659.
- E C E 817 POWER SYSTEM TRANSIENTS**  
3 cr. (3 and 0)  
Electrical transients in power systems; frequency domain and time domain techniques for power systems transient analysis; study of capacitor switching, load switching, fault-induced transients, line reclosing and single pole switching. **Prerequisite:** Permission of instructor.
- E C E 818 RANDOM PROCESS APPLICATIONS IN ENGINEERING**  
3 cr. (3 and 0)  
Theory of random processes emphasizing engineering applications; stochastic convergence and limit theorems; martingales; mean-square calculus; Karhunen-Loeve expansions; systems with stochastic inputs; Poisson processes; shot noise; Weiner processes; white noise processes; Markov systems; queuing systems; and estimate theory. **Prerequisites:** E C E 317 and 330 or permission of instructor.
- E C E 819 DETECTION AND ESTIMATION THEORY**  
3 cr. (3 and 0)  
Theory of statistical testing of hypotheses applied to detection and estimation of communication signal parameters; detection of signals with random amplitude, phase and arrival time in noise; detection of single and multiple observation; estimates and their properties; signal resolution. **Prerequisite:** E C E 820.
- E C E 820 DIGITAL COMMUNICATION SYSTEMS I**  
3 cr. (3 and 0)  
Modern communications systems emphasizing modulation and methods of taking into account effects of noise on various systems. **Prerequisite:** E C E 428/628 or equivalent.
- E C E 821 DIGITAL COMMUNICATION SYSTEMS II**  
3 cr. (3 and 0)  
Continuation of E C E 820.
- E C E 822 INFORMATION THEORY**  
3 cr. (3 and 0)  
Statistical problems encountered in information handling; relations of probability, information and coding theory; unified treatment of set theory, sample space, random variables, information measure and capacity applied to communication.



- E C E 823 INTEGRATED CIRCUIT TECHNOLOGY**  
3 cr. (3 and 0)  
Physical and chemical principles underlying the major processing operations used in the fabrication of integrated circuit semiconductor devices, process simulation, diagnostic testing, and factors affecting device yield and reliability. **Prerequisite:** Permission of instructor.
- E C E 825 SOLID-STATE ELECTRONICS**  
3 cr. (3 and 0)  
Modern physics approach to electrons in solids; elementary quantum mechanics; statistics; plasmas; band theory; application of these principles to modern amplifiers; e.g., the traveling-wave tube, tunnel diode, masers and parametric amplifiers.
- E C E 830 ELECTROMAGNETICS**  
3 cr. (3 and 0)  
Vector analysis; electrostatics; electrostatic fields in material bodies; solution of boundary-value problems; stationary currents; static magnetic fields; magnetic fields in material bodies; quasi-stationary magnetic fields. **Prerequisite:** Permission of instructor.
- E C E 831 ADVANCED ELECTROMAGNETIC THEORY**  
3 cr. (3 and 0)  
Advanced boundary-value problems in cylindrical and spherical coordinates, special functions, Sommerfeld integrals, Green's functions and integral equations. **Prerequisite:** E C E 830.
- E C E 834 ASYMPTOTIC METHODS AND DIFFRACTION THEORY**  
3 cr. (3 and 0)  
Canonical diffraction problems for which exact solutions are available; asymptotic re-evaluation of these solutions in terms of incident, reflected and diffracted rays leads to Keller's postulates for an extended theory or geometrical theory of diffraction; diffraction from edges and curved surfaces is applied to scattering and antenna problems. **Prerequisite:** E C E 830.
- E C E 836 MICROWAVE CIRCUITS AND SYSTEMS**  
3 cr. (3 and 0)  
Application of the mathematics and physical principles of electromagnetic field theory and electrical circuit analysis to the geometries that are of interest in modern microwave engineering; transmission lines, waveguides, discontinuities, interconnection of multiports and periodic structures. **Prerequisite:** E C E 436. **Corequisite:** E C E 830.
- E C E 837 ADVANCED ANTENNA THEORY**  
3 cr. (3 and 0)  
The antenna as a radiating and receiving device; examination by classical and numerical techniques of the relations between structure and performance, gain and terminal conditions. **Prerequisite:** E C E 446. **Corequisite:** E C E 830.
- E C E 838 SPECIAL TOPICS IN ELECTROMAGNETICS**  
1 cr. (1 and 0)  
Methods of solving selected electromagnetic problems with emphasis on Green's functions, equivalence principle, dynamic potential theory and boundary value techniques. May be repeated for credit. **Prerequisite:** Permission of instructor.
- E C E 839 INTEGRAL EQUATIONS IN ELECTROMAGNETICS**  
3 cr. (3 and 0)  
Integral equation formulation in electromagnetics, solution techniques, moment methods and application to practical problems. **Prerequisite:** E C E 830 or permission of instructor.
- E C E 840 PHYSICS OF SEMICONDUCTOR DEVICES**  
3 cr. (3 and 0)  
Semiconductor device physics emphasized rather than circuits; detailed analysis of the p-n junction, traps, surface states and conduction processes in devices; analysis and models of Schottky diode, MIS diode, MOSFET, charge couples devices and solar cells; charge control concepts, transit time effects, surface-type devices and practical aspects of device process. **Prerequisites:** E C E 404 and 406/606.
- E C E 841 DISTRIBUTED COMPUTING AND NETWORKS\***  
3 cr. (3 and 0) S
- E C E 842 COMPUTER ARCHITECTURE\***  
3 cr. (3 and 0) S
- E C E 844 DIGITAL SIGNAL PROCESSING**  
3 cr. (3 and 0)  
Digital filter design; discrete Hilbert transforms; discrete random signals; effects of finite register length in digital signal processing; homomorphic signal processing; power spectrum estimation; speech processing, radar and other applications. **Prerequisite:** E C E 467/667.
- E C E 845 COMPUTER SYSTEM DESIGN AND OPERATION\***  
3 cr. (3 and 0)
- E C E 846 DIGITAL PROCESSING OF SPEECH SIGNALS**  
3 cr. (3 and 0)  
Application of digital signal processing techniques to problems related to speech synthesis, recognition and communication; digital models and representations of speech wave forms; Fourier analysis; homomorphic processing; linear predictive coding; algorithms for recognizing isolated words and continuous speech; man-machine communications by voice. **Prerequisite:** E C E 467.
- E C E 847 DIGITAL IMAGE PROCESSING**  
3 cr. (3 and 0)  
Digital image fundamentals; comparison of image transforms, including KL, Fourier, Walsh, Hadamard, cosine and slant; image data compression techniques; image enhance-

\* Descriptions of these courses are listed under Computer Engineering.



ment algorithms; image restoration; image encoding process; image segmentation and description. **Prerequisite:** E C E 467.

- E C E 849 ADVANCED TOPICS IN COMPUTER COMMUNICATIONS\***  
3 cr. (3 and 0)
- E C E 850 COMPUTATION AND SIMULATION\***  
3 cr. (3 and 0)
- E C E 851 ADVANCED TOPICS IN COMPUTER ARCHITECTURE\***  
3 cr. (3 and 0)
- E C E 852 SOFTWARE ENGINEERING\***  
3 cr. (3 and 0) F
- E C E 854 (M E 854) ANALYSIS OF ROBOTIC SYSTEMS**  
3 cr. (3 and 0)  
Methods of designing and operating robotics systems for advanced automation; on-line identification and description of 3D objects by digitized images; off-line collision-free path planning and on-line collision avoidance traveling using artificial intelligence. **Prerequisite:** E C E/M E 456 or permission of instructor.
- E C E 855 ARTIFICIAL INTELLIGENCE\***  
3 cr. (3 and 0)
- E C E 856 PATTERN RECOGNITION**  
3 cr. (3 and 0)  
Several approaches to general pattern recognition problems with practical computer-oriented applications; feature extraction; classification algorithms; discriminant functions; learning schemes; statistical methods; information theoretic approaches; applications; current developments.
- E C E 857 CODING THEORY**  
3 cr. (3 and 0)  
Principles of algebraic coding and its application to transmission of information over noisy communications channels; introduction to abstract algebra; code performance bounds; code representations; linear codes of the Hamming and Bose-Chandhuri types and burst-error correcting codes; problems of implementation and decoding. **Prerequisite:** E C E 822.
- E C E 859 (M E 859) INTELLIGENT ROBOTIC SYSTEMS**  
3 cr. (3 and 0)  
Integration and fusion of data from multiple sensors on multiple robots; intelligent decision making on motion planning and execution based on sensed data, involving mutual compliance, simultaneous force and position controls using computers. **Prerequisite:** E C E/M E 854 or permission of instructor.
- E C E 861 COMPUTER RELAYING OF POWER SYSTEMS**  
3 cr. (3 and 0)  
Principles of digital protection schemes; application to the digital protection of power system

components; transmission lines, generators, motors and transformers; detection of power system frequency deviation and load shedding techniques; fault location techniques and identification of power systems disturbances. **Prerequisites:** E C E 418/618 and permission of instructor.

- E C E 862 REAL TIME COMPUTER APPLICATION IN POWER SYSTEMS**  
3 cr. (3 and 0)  
Principles of monitoring, control and operation of power systems; load frequency control, on-line load flow, power system state estimation, unit commitment and load forecasting. **Prerequisite:** E C E 418/618.
- E C E 863 POWER SYSTEM DYNAMICS AND STABILITY**  
3 cr. (3 and 0)  
Modeling of synchronous machines and their control systems; study of power system stability for small and large disturbances; excitation systems, governor control, power system stabilizers and state variables formulation for power systems dynamic stability studies. **Prerequisites:** E C E 418/618 and 419/619.
- E C E 872 ARTIFICIAL NEURAL NETWORKS**  
3 cr. (3 and 0)  
Design, analysis and application of artificial neural networks. Topics include neuron models, network architectures, training (supervised and unsupervised) and hardware implementation; extended studies of selected applications and simulation exercises. **Prerequisites:** MTHSC 311 or permission of instructor, and graduate standing.
- E C E 890 ENGINEERING REPORT RESEARCH**  
Variable credit hours.  
Research culminating in writing an engineering report to satisfy one of the requirements for the nonthesis option for the Master of Science degree. The engineering report is similar to the thesis but requires only departmental approval. Graded on a pass/fail basis.
- E C E 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- E C E 892 SPECIAL PROBLEMS IN ELECTRICAL AND COMPUTER ENGINEERING**  
1-3 cr. (1-3 and 0)  
Term paper, special design or other problems in electrical and computer engineering approved by the instructor; not to be used for investigation associated with the M.S. thesis or the engineering report. May be repeated for additional credit.
- E C E 893 SELECTED TOPICS IN ELECTRICAL AND COMPUTER ENGINEERING**  
1-3 cr. (1-3 and 0)  
Topics not covered in other courses; current literature and results of current research. Topics vary from year to year in keeping with developments in the field. May be repeated for additional credit. **Prerequisite:** Permission of instructor.

\* Descriptions of these courses are listed under Computer Engineering.



**E C E 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

**Management Science**

Peter R. Nelson, Program Coordinator, Department of Mathematical Sciences

<b>Major</b>	<b>Degrees</b>
Management Science	M.S., Ph.D.

See the College of Business and Public Affairs for information on this program.

**Mathematical Sciences**

Robert E. Fennell, Chair, Department of Mathematical Sciences

<b>Major</b>	<b>Degrees</b>
Mathematical Sciences	M.S., Ph.D.

Entering students are expected to have courses in linear algebra, differential equations, a computer language and statistics.

For the master's program, both thesis and nonthesis options are available. The curriculum for both options includes foundation courses (advanced calculus, modern algebra, probability and discrete computing — courses often taken prior to entering the master's program); a breadth requirement (a course from each of algebra, analysis, computing, operations research and statistics plus one additional course in operations research or statistics); and a concentration area (six courses selected to define an identifiable specialty area). Every student's program is required to include at least one course, possibly chosen from outside the Department of Mathematical Sciences, which emphasizes mathematical modeling. A minimum of 36 graduate hours is required for the master's degree. In addition, students in the nonthesis option are required to complete a one-credit-hour project course.

Students in the doctoral program are expected to satisfy the master's program requirements prior to receiving their doctorate. Including master's study, a doctoral program must have two courses from each of the major areas of the mathematical sciences (algebra, analysis, computing, operations research and probability/statistics), and generally consists of 60 hours of graduate course work. Students are admitted to candidacy for the Ph.D. degree upon successful completion of a qualifying examination in three areas chosen from algebra, analysis, computing, operations research, statistics and stochastic processes. A student's Ph.D. program must include both a concentration area and a supporting area.

The departments of Management (College of Business and Public Affairs) and Mathematical Sciences jointly offer and administer a doctoral program in management science. It is described under Management Science in the College of Business and Public Affairs.

Mathematical sciences courses at the 700-level are applicable to master's degree programs in the School of Education only.

<b>MTHSC 600</b>	<b>THEORY OF PROBABILITY</b> 3 cr. (3 and 0)
<b>MTHSC 601</b>	<b>STATISTICAL METHODOLOGY</b> 3 cr. (3 and 0)
<b>MTHSC 603</b>	<b>INTRODUCTION TO STATISTICAL THEORY</b> 3 cr. (3 and 0)
<b>MTHSC 605</b>	<b>STATISTICAL THEORY AND METHODS II</b> 3 cr. (3 and 0)
<b>MTHSC 606</b>	<b>SAMPLING THEORY AND METHODS</b> 3 cr. (3 and 0)

<b>MTHSC 607</b>	<b>REGRESSION AND TIME SERIES ANALYSIS</b> 3 cr. (3 and 0)
<b>MTHSC 608</b>	<b>TOPICS IN GEOMETRY</b> 3 cr. (3 and 0)
<b>MTHSC 612</b>	<b>INTRODUCTION TO MODERN ALGEBRA</b> 3 cr. (3 and 0)
<b>MTHSC 619</b>	<b>DISCRETE MATHEMATICAL STRUCTURES</b> 3 cr. (3 and 0)
<b>MTHSC 634</b>	<b>ADVANCED ENGINEERING MATHEMATICS</b> 3 cr. (3 and 0)
<b>MTHSC 635</b>	<b>COMPLEX VARIABLES</b> 3 cr. (3 and 0)
<b>MTHSC 640</b>	<b>LINEAR PROGRAMMING</b> 3 cr. (3 and 0)
<b>MTHSC 641</b>	<b>INTRODUCTION TO STOCHASTIC MODELS</b> 3 cr. (3 and 0)
<b>MTHSC 653</b>	<b>ADVANCED CALCULUS I</b> 3 cr. (3 and 0)
<b>MTHSC 654</b>	<b>ADVANCED CALCULUS II</b> 3 cr. (3 and 0)
<b>MTHSC 660</b>	<b>INTRODUCTION TO NUMERICAL ANALYSIS</b> 3 cr. (3 and 0)
<b>MTHSC 663</b>	<b>MATHEMATICAL ANALYSIS I</b> 3 cr. (3 and 0)
<b>MTHSC 664</b>	<b>MATHEMATICAL ANALYSIS II</b> 3 cr. (3 and 0)
<b>MTHSC 700</b>	<b>MATHEMATICAL COMPUTER APPLICATIONS FOR ELEMENTARY TEACHERS</b> 3 cr. (3 and 0) Use of readily available software as tools in the elementary mathematics curriculum; LOGO language is used in a discovery approach to geometry; spreadsheets are employed to facilitate the organization and statistical processing of classroom data; word processing is integrated with spreadsheets applied to mathematics problem sets, examinations and parental reports.
<b>MTHSC 703</b>	<b>MODERN MATHEMATICS FOR ELEMENTARY SCHOOL TEACHERS — GEOMETRY</b> 3 cr. (3 and 0) Concepts of geometry; informal geometry; measurement of geometric figures; metric measurements; deductive geometry; functions in geometry; coordinate and vector geometry. Restricted to graduate students in elementary and secondary education.
<b>MTHSC 707</b>	<b>MATHEMATICS FOR MIDDLE SCHOOL TEACHERS — ALGEBRA</b> 3 cr. (3 and 0) Algebraic concepts in middle-school mathematics: elementary number theory; the rational, real and complex number systems; polynomials and



rational expressions; equations and inequalities. Restricted to graduate students in elementary and secondary education.

- MTHSC 709 MATHEMATICS FOR MIDDLE SCHOOL TEACHERS — GEOMETRY**  
3 cr. (3 and 0)  
Geometric concepts in middle-school mathematics: lines and planes, angles and triangles, congruence and similarity, circles and spheres, area and volume. Restricted to graduate students in elementary and secondary education.
- MTHSC 710 ELEMENTARY CALCULUS FROM AN ADVANCED VIEWPOINT I**  
3 cr. (3 and 0)  
Origins of calculus; limits; derivative; maxima and minima; continuity; area and other applications of the integral. Restricted to graduate students in elementary and secondary education. **Prerequisite:** MTHSC 108 or its equivalent.
- MTHSC 711 ELEMENTARY CALCULUS FROM AN ADVANCED VIEWPOINT II**  
3 cr. (3 and 0)  
Techniques of integration, logarithmic and exponent functions; applications of integrals; sequences and series. Restricted to graduate students in elementary and secondary education. **Prerequisite:** MTHSC 710 or permission of instructor.
- MTHSC 712 MODERN ALGEBRAIC CONCEPTS**  
3 cr. (3 and 0)  
Development of axioms and fundamental concepts of some modern algebraic structures such as groups, rings and fields; applications to the familiar number systems. Restricted to graduate students in secondary education.
- MTHSC 719 DISCRETE MATHEMATICS**  
3 cr. (3 and 0)  
A survey of discrete mathematics emphasizing applications to computer science; propositions and logic; Boolean Algebra and switching circuits; recursion and induction; relations and partially ordered sets, graphs and trees.
- MTHSC 721 MATRIX ALGEBRA**  
3 cr. (3 and 0)  
Matrices and systems of equations; determinants; vector spaces and linear transformations; eigenvalues. Restricted to graduate students in secondary education.
- MTHSC 723 APPLICATIONS OF LINEAR AND MODERN ALGEBRA**  
3 cr. (3 and 0)  
Various applied problems whose solutions rely on techniques and results of linear and modern algebra; problems selected from such areas as economics, forest management, genetics, population growth, transportation networks, cryptography, satellite communications, electronic switching circuits, chemistry, physics, sociology and others. **Prerequisite:** MTHSC 712, MTHSC 721 or equivalent, or permission of instructor.

- MTHSC 725 COMBINATORIAL MATHEMATICS FOR TEACHERS**  
3 cr. (3 and 0)  
Permutations; combinations; generating functions; recurrence relations; principle of inclusion-exclusion; partitions; Latin squares; block designs; finite geometries; graphs; codes; Polya's theorem; recreational mathematics. Restricted to graduate students in secondary education.
- MTHSC 727 ANALYSIS CONCEPTS FOR TEACHERS**  
3 cr. (3 and 0)  
Elementary functions, differential calculus and integral calculus; enrichment material and a theoretical perspective of calculus. Restricted to teachers who hold a current teaching certificate in secondary mathematics. Completion of this course satisfies the special certification requirements for AB-calculus teachers in South Carolina.
- MTHSC 730 MODERN GEOMETRY FOR TEACHERS**  
3 cr. (3 and 0)  
Concepts of Euclidean geometry reviewed and extended by means of coordinates, vectors, matrices; conic sections. Restricted to graduate students in secondary education.
- MTHSC 732 PROJECTIVE GEOMETRY**  
3 cr. (3 and 0)  
Analytic and synthetic development of properties of projective geometry and its subgeometries, ranging from affine to Euclidean geometry. Restricted to graduate students in secondary education.
- MTHSC 741 INTRODUCTION TO LINEAR PROGRAMMING WITH APPLICATIONS**  
3 cr. (3 and 0)  
Development of mathematical theory of simplex algorithm; survey of mathematical background; matrix algebra, systems of linear equations and vector spaces; problem formulation emphasized. Restricted to graduate students in secondary education.
- MTHSC 751 FUNDAMENTAL CONCEPTS OF CALCULUS**  
3 cr. (3 and 0)  
Set theory; real number system; functions and relations; metric sets and limits; continuity and differentiation; integration. Restricted to graduate students in secondary education. **Prerequisite:** One year of undergraduate calculus.
- MTHSC 761 PROBABILITY AND STATISTICS FOR TEACHERS**  
3 cr. (3 and 0)  
Probability; conditional probability; descriptive statistics; random variables; probability functions; binomial distribution; normal distribution; sampling; estimation; decision making. Restricted to graduate students in secondary education.



- MTHSC 771 NUMERICAL METHODS IN SECONDARY SCHOOL MATHEMATICS**  
3 cr. (3 and 0)  
Update of traditional techniques for teaching high school mathematics through introduction of computer methods for investigation of processes and reinforcement of concepts; development of programs requiring participants to "invent" algorithms to solve problems in the typical high school mathematics course; use of general purpose programming language; methods of teaching this language to high school students. Restricted to graduate students in secondary education.
- MTHSC 783 THEORY OF NUMBERS**  
3 cr. (3 and 0)  
Properties of integers, divisors and prime numbers; fundamental properties of congruence; polynomial and primitive roots; quadratic residues. Restricted to graduate students in secondary education.
- MTHSC 791 SELECTED TOPICS IN MATHEMATICS EDUCATION**  
1-3 cr. (1-3 and 0)  
Mathematical problems in curriculum of elementary or secondary school. Restricted to graduate students in elementary or secondary education. May be repeated for credit, but only if different topics are covered.
- MTHSC 800 PROBABILITY**  
3 cr. (3 and 0) F  
Basic probability theory with emphasis on results and techniques useful in operations research and statistics. Topics include axiomatic probability, advanced combinatorial probability, conditional informative expectation, functions of random variables, moment generating functions, distribution theory and limit theorems. **Prerequisite:** MTHSC 206.
- MTHSC 801 GENERAL LINEAR HYPOTHESIS I**  
3 cr. (3 and 0) F  
Least-square estimates; Gauss-Markov theorem; confidence ellipsoids and confidence intervals for estimable functions; tests of hypotheses; one-, two- and higher-way layouts; analysis of variance for other models. **Prerequisites:** MTHSC 403/603 and 311.
- MTHSC 802 GENERAL LINEAR HYPOTHESIS II**  
3 cr. (3 and 0) S  
Continuation of MTHSC 801.
- MTHSC 803 STOCHASTIC PROCESSES**  
3 cr. (3 and 0) S, SS  
Theory and analysis of time series; recurrent events; Markov chains; random walks; renewal theory; application to communication theory; operations research. **Prerequisite:** MTHSC 400/600 or 800.
- MTHSC 805 DATA ANALYSIS**  
3 cr. (3 and 0) F, S  
Methodology in analysis of statistical data emphasizing applications to real problems using computer-oriented techniques: computer plots, transformations, criteria for selecting variables, error analysis, multiple and stepwise regression, analysis of residuals, model building in time series and ANOVA problems, jackknife and random subsampling, multidimensional scaling, clustering. **Prerequisites:** MTHSC 301 and 400/600, or MTHSC 401/601 and 800.
- MTHSC 806 NONPARAMETRIC STATISTICS**  
3 cr. (3 and 0) F  
Order statistics; tolerance limits; rank-order statistics; Kolmogorov-Smirnov one-sample statistics; Chi-square goodness-of-fit test; two-sample problem; linear rank statistics; asymptotic relative efficiency. **Prerequisite:** MTHSC 600 or 800.
- MTHSC 807 APPLIED MULTIVARIATE ANALYSIS**  
3 cr. (3 and 0) F  
Applied multivariate analysis: computer plots of multivariate observations; multidimensional scaling; multivariate tests of means, covariances and equality of distributions; univariate and multivariate regressions and their comparisons; MANOVA; principle components analysis; factor analysis; analytic rotations; canonical correlations. **Prerequisites:** MTHSC 403/603 and 805 or permission of instructor.
- MTHSC 808 RELIABILITY AND LIFE TESTING**  
3 cr. (3 and 0) S  
Probability models and statistical methods relevant to parametric and nonparametric analysis of reliability and life testing data. **Prerequisites:** MTHSC 400/600 and 401/601 or equivalent.
- MTHSC 809 TIME SERIES ANALYSIS, FORECASTING AND CONTROL**  
3 cr. (3 and 0) F  
Modeling and forecasting random processes; autocorrelation functions and spectral densities; model identification, estimation and diagnostic checking; transfer function models; feedforward and feedback control schemes. **Prerequisites:** MTHSC 600 and 605, or MTHSC 800 and 605, or equivalent.
- MTHSC 810 MATHEMATICAL PROGRAMMING**  
3 cr. (3 and 0) F, S  
Formulation and solution of linear programming models; mathematical development of the simplex method; revised simplex method; duality; sensitivity analysis; parametric programming, implementation, software packages. **Prerequisite:** MTHSC 311.
- MTHSC 811 NONLINEAR PROGRAMMING**  
3 cr. (3 and 0) S  
Theoretical development of nonlinear optimization with applications; classical optimization; convex and concave functions; separable programming; quadratic programming; gradient methods. **Prerequisites:** MTHSC 440 and 454.



- MTHSC 812 DISCRETE OPTIMIZATION**  
3 cr. (3 and 0) F  
Principal methods used in integer programming and discrete optimization. Topics include branch and bound, implicit enumeration, cutting planes, group knapsack, Lagrangian relaxation, surrogate constraints, heuristics (performance analysis), separation/branching strategies and polynomial time algorithms for specific problems on special structures. **Prerequisite:** MTHSC 810 or equivalent.
- MTHSC 813 ADVANCED LINEAR PROGRAMMING**  
3 cr. (3 and 0) S  
Development of linear programming theory using inequality systems, convex cones, polyhedra and duality; solution algorithms and computational considerations for large scale and special structured problems using techniques of upper bounded variables, decomposition, partitioning and column generation; game theory; nonlinear representations and other methods such as ellipsoid and Karmarkar. **Prerequisite:** MTHSC 440/640, 810 or equivalent.
- MTHSC 814 NETWORK FLOW PROGRAMMING**  
3 cr. (3 and 0) F  
Max-flow/min-cut theorem; combinatorial applications; minimum cost flow problems (transportation, shortest path, transshipment); solution algorithms (including the out-of-kilter); implementation and computational considerations. **Prerequisite:** MTHSC 440/640, 810 or equivalent.
- MTHSC 816 NETWORK ALGORITHMS AND DATA STRUCTURES**  
3 cr. (3 and 0) F  
Design, analysis and implementation of algorithms and data structures associated with the solution of problems formulated as networks and graphs; applications to graph theory, combinatorial optimization and network programming. **Corequisite:** MTHSC 640, 810, 854, 863 or permission of instructor.
- MTHSC 817 STOCHASTIC MODELS IN OPERATIONS RESEARCH I**  
3 cr. (3 and 0) F  
Stochastic control; structure of sequential decision processes; stochastic inventory models; recursive computation of optimal policies; discrete parameter finite Markov decision processes; various optimality criteria; computation by policy improvement and other methods; existence of optimal stationary policies; stopping-rule problems; examples from financial management, maintenance and reliability, search, queuing and shortest path. **Prerequisite:** MTHSC 803.
- MTHSC 818 STOCHASTIC MODELS IN OPERATIONS RESEARCH II**  
3 cr. (3 and 0) S  
Introduction to queuing theory: Markovian queues, repairman problems, queues with an embedded Markov structure, the queue GI/G/1, queues with a large number of servers, decision making in queues; introduction to reliability theory; failure distributions; stochastic models for complex systems; maintenance and replacement policies; reliability properties of multicomponent structures. **Prerequisite:** MTHSC 817.
- MTHSC 819 MULTICRITERIA OPTIMIZATION**  
3 cr. (3 and 0) S  
Theory and methodology of optimization problems with vector-valued objective functions; preference orders and domination structures; generating "efficient" solutions; solving multicriteria decision-making problems, noninteractive and interactive methods with applications. **Prerequisite:** MTHSC 810 or equivalent.
- MTHSC 820 COMPLEMENTARITY MODELS**  
3 cr. (3 and 0) S  
Theory, algorithms and applications of linear and nonlinear complementarity; classes of matrices and functions and corresponding algorithms; applications to economics, mechanics and networks; generalizations to fixed-point problems and nonlinear systems of equations. **Prerequisite:** MTHSC 810.
- MTHSC 821 LINEAR ANALYSIS**  
3 cr. (3 and 0) S, SS  
Normed spaces; Hilbert spaces, Banach spaces, linear functionals, linear operators, orthogonal systems. **Prerequisites:** MTHSC 454/654 or MTHSC 453 and 853.
- MTHSC 822 MEASURE AND INTEGRATION**  
3 cr. (3 and 0) F  
Rings and algebras of sets, inner and outer measures; measurability and additivity, examples on the line and in space, Lebesgue integration, types of convergence, Lebesgue spaces; integration and differentiation, product measure, Fubini theorem. **Prerequisite:** MTHSC 454/654.
- MTHSC 823 COMPLEX ANALYSIS**  
3 cr. (3 and 0)  
Topological concepts; complex integration; local and global properties of analytic functions; power series; representation theorems; calculus of residues. Designed for nonengineering majors. **Prerequisite:** MTHSC 464/664.
- MTHSC 825 INTRODUCTION TO DYNAMICAL SYSTEMS THEORY**  
3 cr. (3 and 0) F  
Techniques of analysis of dynamical systems. Topics include sensitivity analysis, linear systems, stability and control; the theory of differential and difference equations is emphasized. **Prerequisites:** MTHSC 454/654 and 311, or MTHSC 453 and 853.
- MTHSC 826 PARTIAL DIFFERENTIAL EQUATIONS**  
3 cr. (3 and 0) F  
First-order equations: elliptic, hyperbolic and parabolic; second-order equations: existence and uniqueness results, maximum principles, finite difference and Hilbert Space methods. **Prerequisite:** MTHSC 821 or permission of instructor.



- MTHSC 827 DYNAMICAL SYSTEM NEURAL NETWORKS**  
3 cr. (3 and 0)  
Modeling problems in the context of dynamical systems theory; useful methods from Lyapunov stability, local linearization, qualitative analysis using graph theory and numerical approximations; several dynamical systems neural networks including binary code recognizers and binary matrix choosers. **Prerequisites:** MTHSC 206 and MTHSC 311.
- MTHSC 831 FOURIER SERIES**  
3 cr. (3 and 0) SS  
Fourier series with applications to solution of boundary value problems in partial differential equations of physics and engineering; introduction to Bessel functions and Legendre polynomials. **Prerequisite:** MTHSC 464/664.
- MTHSC 837 CALCULUS OF VARIATIONS AND OPTIMAL CONTROL**  
3 cr. (3 and 0) SS  
Fundamental theory of the calculus of variations; variable end points; the parametric problem; the isoperimetric problem; constraint inequalities; introduction to the theory of optimal control; connections with the calculus of variations; geometric concepts. **Prerequisite:** MTHSC 453/653 or 463/663.
- MTHSC 841 APPLIED MATHEMATICS I**  
3 cr. (3 and 0) F  
Derivation of equations from conservation laws, dimensional analysis, scaling and simplification; methods such as steepest descent, stationary phase, perturbation series, boundary layer theory, WKB theory, multiple-scale analysis and ray theory applied to problems in diffusion processes, wave propagation, fluid dynamics and mechanics. **Prerequisites:** MTHSC 208 and 453/653 or MTHSC 463/663.
- MTHSC 842 APPLIED MATHEMATICS II**  
3 cr. (3 and 0)  
Continuation of MTHSC 841.
- MTHSC 851 ABSTRACT ALGEBRA I**  
3 cr. (3 and 0) S  
Survey of some basic algebraic structures: groups, rings and fields. Topics include permutation groups, Sylow theorems, finite abelian groups, polynomial domains, factorization theory and elementary field theory.
- MTHSC 852 ABSTRACT ALGEBRA II**  
3 cr. (3 and 0) F  
A continuation of MTHSC 851 including selected topics from ring theory and field theory.
- MTHSC 853 MATRIX ANALYSIS**  
3 cr. (3 and 0) F, S  
Topics in matrix analysis that support an applied curriculum: similarity and eigenvalues; Hermitian and normal matrices; canonical forms; norms; eigenvalue localizations; singular value decompositions; definite matrices. **Prerequisite:** MTHSC 311, 453 or 463.

- MTHSC 854 THEORY OF GRAPHS**  
3 cr. (3 and 0) S  
Connectedness; path problems; trees; matching theorems; directed graphs; fundamental numbers of the theory of graphs; groups and graphs. **Prerequisite:** Permission of instructor.
- MTHSC 855 COMBINATORIAL ANALYSIS**  
3 cr. (3 and 0) F  
Combinations; permutations; permutations with restricted position; Polya's theorem; principle of inclusion and exclusion; partitions; recurrence relations; generating functions; Mobius inversion; enumeration techniques; Ramsey numbers; finite projective and affine geometries; Latin rectangles; orthogonal arrays; block designs; error detecting and error correcting codes. **Prerequisite:** MTHSC 311.
- MTHSC 856 APPLICABLE ALGEBRA**  
3 cr. (3 and 0) S  
Applied algebraic ideas in lattice theory and Boolean Algebra; finite-state sequential machines; group theory as applied to network complexity and combinatorial enumeration; algebraic coding theory. Topics vary with background and interests of students. **Prerequisites:** MTHSC 851 and 853 or permission of instructor.
- MTHSC 860 AN INTRODUCTION TO SCIENTIFIC COMPUTING**  
3 cr. (3 and 0) S, SS  
Floating point models, conditioning and numerical stability, numerical linear algebra, integration, systems of ordinary differential equations and zero finding; emphasis is on the use of existing scientific software. **Prerequisites:** MTHSC 208, 311 and CP SC 110.
- MTHSC 861 ADVANCED NUMERICAL ANALYSIS I**  
3 cr. (3 and 0) F  
Interpolation and approximation; numerical quadrature; numerical solution of functional differential equations; integral equations and overdetermined linear systems; eigenvalue problems; approximation using splines. **Prerequisites:** MTHSC 453 and 460.
- MTHSC 862 ADVANCED NUMERICAL ANALYSIS II**  
3 cr. (3 and 0) S  
Continuation of MTHSC 861.
- MTHSC 863 DIGITAL MODELS I**  
3 cr. (3 and 0) F  
Experimental mathematics; pseudo-stochastic processes; analytical and algebraic formulations of time-independent simulation; continuous-time simulation and discrete-time simulation; digital optimization; Fibonacci search; ravine search; gradient methods; current research in digital analysis. **Prerequisites:** MTHSC 311, 453/653 and digital computer experience.
- MTHSC 864 DIGITAL MODELS II**  
3 cr. (3 and 0)  
Continuation of MTHSC 863.



- MTHSC 865 DATA STRUCTURES**  
3 cr. (3 and 0) F  
Representation and transformation of information; formal description of processes and data structures; tree and list structures; pushdown stacks; string and formula manipulation; hashing techniques; interrelation between data structure and program structure; storage allocation methods. **Prerequisites:** Computational maturity and permission of instructor.
- MTHSC 881 MATHEMATICAL STATISTICS**  
3 cr. (3 and 0) S  
Fundamental concepts of sufficiency, hypothesis testing and estimation; robust estimation; resampling (jackknife, bootstrap, etc.) methods; asymptotic theory; two-stage and sequential sampling problems; ranking and selection procedures. **Prerequisite:** MTHSC 403/603 or equivalent.
- MTHSC 882 MONTE CARLO METHODS**  
3 cr. (3 and 0) F  
Random number generators, discrete and continuous random variate generation and approximations, random vector generation, Monte Carlo integration, variance reduction techniques. **Prerequisites:** MTHSC 800 and 603.
- MTHSC 885 ADVANCED DATA ANALYSIS**  
3 cr. (3 and 0) F  
Continuation of MTHSC 805, covering alternatives to ordinary least squares, influence and diagnostic considerations, robustness, special statistical computation methods. **Prerequisites:** MTHSC 603, 800 and 805.
- MTHSC 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged. F, S, SS
- MTHSC 892 MASTER'S PROJECT COURSE**  
1 cr. (0 and 1) F, S, SS  
For students in the nonthesis option of the Master of Science degree program in the mathematical sciences. Successful completion includes a presentation of the master's project to the student's advisory committee and acceptance of the paper by the committee.
- MTHSC 900 SEMINAR IN PREPARING FOR COLLEGE TEACHING IN THE MATHEMATICAL SCIENCES**  
3 cr. (3 and 0) N  
Examination of many of the elements involved in being a college professor with special emphasis on broadening the student's mathematical experiences within a framework of improving classroom performance. **Prerequisite:** Completion of the departmental Ph.D. qualifying examinations.
- MTHSC 901 PROBABILITY THEORY I**  
3 cr. (3 and 0) N  
Axiomatic theory of probability; distribution functions; expectation; Cartesian product of infinitely many probability spaces and the Kolmogorov consistency theorem; models of convergence; weak and strong laws of large numbers. **Prerequisites:** MTHSC 400/600 and 822, or MTHSC 800 and 822, or permission of instructor.
- MTHSC 902 PROBABILITY THEORY II**  
3 cr. (3 and 0) N  
Continuation of MTHSC 901; characteristic functions, infinitely divisible distributions, central limit theorems, laws of large numbers, conditioning and limit properties of sums of dependent random variables, conditioning, martingales. **Prerequisite:** MTHSC 901.
- MTHSC 907 MULTIVARIATE ANALYSIS**  
3 cr. (3 and 0) N  
Multivariate normal distribution; Wishart distribution; Hotellings  $T^2$  distribution; estimation of parameters; test of hypotheses on vector means and covariance matrices. **Prerequisite:** MTHSC 802.
- MTHSC 927 FUNCTIONAL ANALYSIS**  
3 cr. (3 and 0) N  
Linear operators on specific spaces, spectral theory, semigroups of operators and the Hille-Yosida theorem, applications of linear spaces and operators, convexity. **Prerequisite:** MTHSC 821.
- MTHSC 954 ADVANCED GRAPH THEORY**  
3 cr. (3 and 0) F  
Continuation of MTHSC 854; topics not covered in 854, including the four-color theorem, domination numbers, Ramsey theory, graph isomorphism, embeddings, algebraic graph theory and tournaments; research papers are also examined. **Prerequisite:** MTHSC 854 or permission of instructor.
- MTHSC 981 SELECTED TOPICS IN MATHEMATICAL STATISTICS AND PROBABILITY**  
1-3 cr. (1-3 and 0)  
Advanced topics in mathematical statistics and probability of current interest. May be repeated for credit, but only if different topics are covered.
- MTHSC 982 SELECTED TOPICS IN ANALYSIS**  
1-3 cr. (1-3 and 0)  
Advanced analysis topics from current problems of interest. May be repeated for credit, but only if different topics are covered.
- MTHSC 983 SELECTED TOPICS IN COMPUTATIONAL MATHEMATICS**  
1-3 cr. (1-3 and 0)  
Advanced topics in computational mathematics and numerical analysis from current problems of interest. May be repeated for credit, but only if different topics are covered.
- MTHSC 985 SELECTED TOPICS IN ALGEBRA AND COMBINATORICS**  
1-3 cr. (1-3 and 0)  
Advanced topics in algebra and combinatorics from current problems of interest. May be repeated for credit, but only if different topics are covered.



<b>MTHSC 986</b>	<b>SELECTED TOPICS IN GEOMETRY</b> 1-3 cr. (1-3 and 0) Advanced topics in geometry from current problems of interest. May be repeated for credit, but only if different topics are covered.
<b>MTHSC 988</b>	<b>SELECTED TOPICS IN OPERATIONS RESEARCH</b> 1-3 cr. (1-3 and 0) Advanced topics in operations research from current problems of interest. May be repeated for credit, but only if different topics are covered.
<b>MTHSC 991</b>	<b>DOCTORAL DISSERTATION RESEARCH</b> Credit to be arranged.

## Physics

Peter J. McNulty, Chair, Department of Physics and Astronomy

<b>Major</b> Physics	<b>Degrees</b> M.S., Ph.D.
-------------------------	-------------------------------

Graduate studies in physics and astronomy may be pursued by well-prepared students in the physical and mathematical sciences or engineering. As the basic physical science, physics offers intellectual opportunities of an unparalleled nature. Theoretical, experimental or computer-simulated studies of the physical universe, ranging from the macroscopic studies of cosmology to the microscopic world of quanta, are available.

All graduate student progress is evaluated each spring by the Graduate Student Evaluation Committee. This committee reports its recommendations to the faculty, who, in turn, advise the department chair concerning students' performances. The recommendation of the faculty may be (1) continuing satisfactory progress toward Ph.D. candidacy, (2) satisfactory progress toward the master's degree, (3) unsatisfactory progress toward any graduate degree. The department chair considers continuance of the student based, in part, on these recommendations.

Students beginning graduate studies in physics and astronomy usually enter the M.S. program. After two semesters, well-prepared students are ready to begin a research program. This program most often culminates in a thesis, although a nonthesis option is available. For the thesis option, 30 credit hours and a final oral examination on the general area of study and thesis defense are required. In the nonthesis option, 36 credit hours are required, including six credit hours of PHYS 890. A written report must be submitted on the directed studies. A final oral examination on the general area and directed activities completes the requirements for the nonthesis option. A program leading to the M.S. degree in physics with a concentration in health physics is available. Six credits of health physics or biophysics and nine credits of courses in biology, biochemistry or chemistry are required in this option.

Study for the Ph.D. degree begins with the general qualifying examination. A sufficiently high score on this examination may make it possible for a student to bypass the master's degree. An oral examination on the general research area is given within six months after completion of the written qualifying examination. At least three weeks prior to the convocation at which the student expects to receive the Ph.D. degree, a final oral examination on the dissertation must be completed.

<b>PHYS 617</b>	<b>INTRODUCTION TO BIOPHYSICS</b> 3 cr. (3 and 0)
<b>PHYS 620</b>	<b>ATMOSPHERIC PHYSICS</b> 3 cr. (3 and 0)

<b>PHYS 621</b>	<b>MECHANICS I</b> 3 cr. (3 and 0)
<b>PHYS 622</b>	<b>MECHANICS II</b> 3 cr. (3 and 0)
<b>PHYS 625</b>	<b>EXPERIMENTAL PHYSICS I</b> 3 cr. (1 and 4)
<b>PHYS 626</b>	<b>EXPERIMENTAL PHYSICS II</b> 3 cr. (1 and 4)
<b>PHYS 632</b>	<b>OPTICS</b> 3 cr. (3 and 0)
<b>PHYS 641</b>	<b>ELECTROMAGNETICS I</b> 3 cr. (3 and 0)
<b>PHYS 642</b>	<b>ELECTROMAGNETICS II</b> 3 cr. (3 and 0)
<b>PHYS 646</b>	<b>SOLID STATE PHYSICS</b> 3 cr. (3 and 0)
<b>PHYS 652</b>	<b>NUCLEAR AND PARTICLE PHYSICS</b> 3 cr. (3 and 0)
<b>PHYS 655</b>	<b>QUANTUM PHYSICS I</b> 3 cr. (3 and 0)
<b>PHYS 656</b>	<b>QUANTUM PHYSICS II</b> 3 cr. (3 and 0)
<b>PHYS 665</b>	<b>THERMODYNAMICS AND STATISTICAL MECHANICS</b> 3 cr. (3 and 0)
<b>PHYS 675</b>	<b>SELECTED TOPICS</b> 1-3 cr. (0-3 and 0-9)
<b>PHYS 710</b>	<b>SELECTED TOPICS FOR TEACHERS</b> 1-6 cr. (0-6 and 0-18) One or more topics are discussed; lecture and laboratory emphasize the incorporation of new or updated subject matter into classroom instruction. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered. <b>Prerequisite:</b> Permission of instructor.
<b>PHYS 811</b>	<b>METHODS OF THEORETICAL PHYSICS I</b> 3 cr. (3 and 0) Analytical methods and techniques used in theoretical physics: vector and tensor analysis as applied to physical problems, use of matrices and groups in classical and quantum mechanics, complex variables and partial differential equations of physics.
<b>PHYS 812</b>	<b>METHODS OF THEORETICAL PHYSICS II</b> 3 cr. (3 and 0) Continuation of PHYS 811: use of integral transforms, integral equations, special functions, calculus of variations and numerical approximations in solutions of physical problems.
<b>PHYS 815 (M E 815)</b>	<b>STATISTICAL THERMODYNAMICS I</b> 3 cr. (3 and 0) Fundamental principles of kinetic theory and quantum statistical mechanics; Boltzmann statistics, Fermi-Dirac statistics and Bose-



Einstein statistics. **Prerequisite:** A course in thermodynamics or permission of instructor.

- PHYS 816 STATISTICAL THERMODYNAMICS II**  
3 cr. (3 and 0)  
Generalized ensemble theory and fluctuations; applications to solids, liquids, gases and blackbody radiation. **Prerequisite:** PHYS 815.
- PHYS 821 CLASSICAL MECHANICS I**  
3 cr. (3 and 0)  
Dynamics of particles; variational principles and Lagrange's equations; two-body central force problems; dynamics of rigid bodies; matrix formulations freely used.
- PHYS 822 CLASSICAL MECHANICS II**  
3 cr. (3 and 0)  
Special relativity in classical mechanics; Hamilton's equations; canonical transformations; Hamilton-Jacobi theory; small oscillations.
- PHYS 841 ELECTRODYNAMICS I**  
3 cr. (3 and 0)  
Field theory of electromagnetism; Maxwell's equations and their application to study of electromagnetic wave production and propagation; wave optics and theories of interference and diffraction.
- PHYS 842 ELECTRODYNAMICS II**  
3 cr. (3 and 0)  
Production and propagation of electromagnetic waves beginning with use of Maxwell's equations; wave guides; diffraction phenomenon; boundary effects; theory of electrons and microscopic phenomena.
- PHYS 845 SOLID STATE PHYSICS I**  
3 cr. (3 and 0)  
Physical properties of crystalline solids; crystalline state determination by diffraction methods; theories of specific heat; properties of metallic lattices and alloys; lattice energy and ferroelectrics.
- PHYS 846 SOLID STATE PHYSICS II**  
3 cr. (3 and 0)  
Continuation of PHYS 845: electronic properties of solids, band theory of solids, physics of semiconductors, theories of magnetism and magnetic resonance phenomena.
- PHYS 852 RADIATION PHYSICS**  
3 cr. (3 and 0)  
The interactions and basic mechanisms involved in the natural radiation environments of space, which include a variety of energetic, charged particles with sufficient energy to penetrate heavily shielded spacecraft and pose potential hazards to astronauts and electronic systems. **Prerequisite:** Undergraduate degree in physics or electrical engineering or permission of instructor.
- PHYS 875 SELECTED TOPICS**  
1-3 cr. (1-3 and 0)  
Students and interested faculty study areas of physics currently being extensively investi-

gated. May be repeated for credit, but only if different topics are covered.

- PHYS 890 DIRECTED ACTIVITIES IN APPLIED PHYSICS**  
1-6 cr.  
Training and work on practical problems; activities are supervised by department faculty or by appropriate adjunct professor; written description of student's activities must be submitted to course supervisor at completion of activity. Maximum credit limits are six credit hours in a semester and three credit hours in a single summer session. Graded on a pass/fail basis.
- PHYS 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- PHYS 951 QUANTUM MECHANICS I**  
3 cr. (3 and 0)  
Review of wave mechanics; operator algebra and theory of representation; approximate methods for stationary problems; theory of scattering applied to atomic and nuclear problems.
- PHYS 952 QUANTUM MECHANICS II**  
3 cr. (3 and 0)  
Continuation of PHYS 951; time-dependent perturbations, radiation, absorption and emission, relativistic quantum mechanics, introduction to quantum electrodynamics.
- PHYS 966 RELATIVITY**  
3 cr. (3 and 0)  
Special and general theory of relativity including tensor calculus, Lorentz transformation and three experimental tests of general theory: (1) planetary motion and advance of perihelion of Mercury, (2) bending of light rays in gravitational fields and (3) gravitational shift of spectral lines.
- PHYS 971 ADVANCED QUANTUM THEORY I**  
3 cr. (3 and 0)  
Development of quantum theory as encountered in systems with an infinite number of degrees of freedom and in systems where relativistic effects are important; advanced scattering theory; quantization of relativistic field theories; development of covariant forms of perturbation theory. **Prerequisite:** PHYS 951 or permission of instructor.
- PHYS 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

#### Astronomy

Students may specialize but not major or minor in astronomy or astrophysics, although their M.S. or Ph.D. degree is awarded in physics.

- ASTR 675 SELECTED TOPICS IN ASTROPHYSICS**  
1-3 cr. (0-3 and 0-9)



**ASTR 802 STELLAR STRUCTURE AND EVOLUTION**  
3 cr. (3 and 0)  
Physical principles governing the structure, power, luminosity and evolution of stars. Topics include equation of state, equations for pressure and thermal balance, heat transport, thermonuclear power and numerical techniques of structure calculation. **Prerequisite:** PHYS 455 or equivalent or permission of instructor.

**ASTR 803 GALACTIC STRUCTURE**  
3 cr. (3 and 0)  
Kinematics, dynamics and content of the Milky Way galaxy. Topics include galactic rotation, galactic distance scale, stellar populations, spiral structure, the galactic center, and the evolution of the Milky Way and other galaxies. **Prerequisite:** Permission of instructor.

**ASTR 805 NUCLEAR ASTROPHYSICS**  
3 cr. (3 and 0)  
Nuclear science applied to problems in astronomy. Topics include nuclear structure, fusion reactions, weak and electromagnetic reactions, nuclear burning in stars and resulting abundances of nuclides. **Prerequisite:** PHYS 455 or equivalent or permission of instructor.

**ASTR 875 SELECTED TOPICS**  
1-3 cr. (1-3 and 0)  
Study of one or more advanced topics in contemporary astrophysics. May be repeated for credit, but only if different topics are covered. **Prerequisite:** Permission of instructor.



Counseling and Educational Leadership • 150

Curriculum and Instruction • 155

Foundations and Special Education • 160

Parks, Recreation and Tourism Management • 162

Public Health • 164

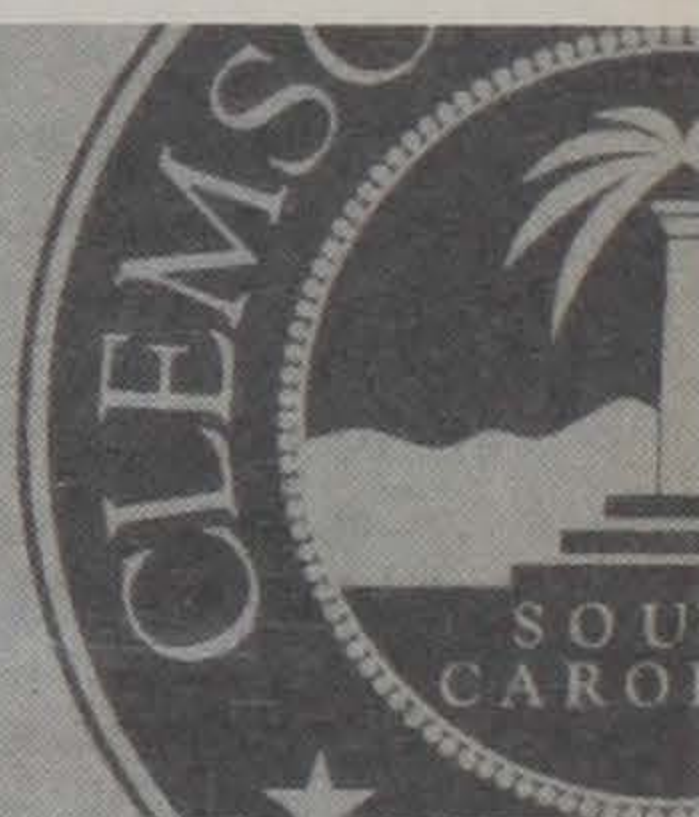
Technology and Human Resource Development • 165

Industrial Education • 167

Vocational/Technical Education • 168

School of Nursing • 169

COLLEGE OF HEALTH,  
EDUCATION AND  
HUMAN DEVELOPMENT





# COLLEGE OF HEALTH, EDUCATION AND HUMAN DEVELOPMENT

Harold E. Cheatham, Dean

The College of Health, Education and Human Development offers advanced degrees in these areas of study.

Administration and Supervision  
Counseling and Guidance Services  
Curriculum and Instruction  
Educational Leadership  
Elementary Education  
Health Administration  
Human Resource Development  
Industrial Education  
Nursing  
Parks, Recreation and Tourism Management  
Reading  
Secondary Education  
Special Education  
Vocational/Technical Education

Courses are offered in coaching education and health to provide electives for students in other areas.

The College of Health, Education and Human Development offers the Ph.D. degrees in curriculum and instruction and educational leadership. The M.S. degree is offered in nursing. The college also offers professional degree programs leading to the Master of Education, Master of Health Administration, Master of Human Resource Development, Master of Industrial Education, Master of Parks, Recreation and Tourism Management, Specialist in Education and the Doctor of Education degrees. The College of Health, Education and Human Development and the College of Agriculture, Forestry and Life Sciences cooperatively offer a Master of Agricultural Education program. The degree is awarded by the College of Agriculture, Forestry and Life Sciences.

The focus of the graduate program is on preparing students for leadership positions in educational, health care, governmental and business organizations. Clinical and field experiences are common in many graduate programs. Many programs join with local, state and federal agencies to provide real-world experiences and research projects for faculty and students. Many programs and courses are offered off campus and in the evening to accommodate the schedule of public schools, health-care institutions, businesses and other organizations.

The College of Health, Education and Human Development offers graduate courses in the disciplines of education and nursing at various off-campus locations across the state. Off-campus course schedules for fall, spring and summer offerings for school personnel, school districts and other South Carolina agencies are published by the Office of Extension and Public Relations. In addition, courses are taught by contract with local school districts in the Clemson University service region.

## Counseling and Educational Leadership

Jackson L. Flanigan, Chair, Department of Counseling and Educational Leadership

Majors	Degrees
Administration and Supervision	M.Ed., Ed.S.
Counseling and Guidance Services	M.Ed.
Educational Leadership	Ph.D.

Students seeking admission to the Master of Education degree programs with majors in administration and supervision, counseling and guidance services (in the areas of elementary school counseling or secondary school counseling) should have a valid professional teacher's certificate on the appropriate level. Those seeking admission to the counseling and guidance services program in the area of student affairs in higher education must have

an undergraduate degree in a human services area or experience in higher education. Those seeking admission to the community agency area must have 15 hours of sociology and/or psychology, including a course in learning theory and a course in human development.

A major in administration and supervision is offered to experienced teachers (at least one year) who wish to prepare as elementary school administrators or supervisors, or secondary school administrators or supervisors. Appropriate scores on the GRE or the MAT are required. The 39 hours and courses are selected from four areas as prescribed by the Department of Counseling and Guidance Services.

The Specialist in Education degree program in educational administration consists of a minimum of 30 semester hours beyond the master's degree selected from areas prescribed by the Department of Counseling and Guidance Services. Admission requirements include a master's degree and appropriate GRE/MAT scores.

A major in counseling and guidance services requires 48 hours and is offered to those desiring to specialize in guidance counseling in the public schools, higher education or the community agency field. Degree candidates are required to complete a minimum of 33 hours, including six hours of field experience, in the area of specialization; six hours in statistics and research; and 12 to 15 hours in a field related to the area of specialization.

The Doctor of Philosophy degree in educational leadership requires a minimum of 72 semester hours beyond the master's degree, selected from either K-12 administration or higher education administration. Admission requirements include a master's degree and appropriate GRE scores.

EDC 801	<b>FOUNDATIONS OF COUNSELING IN THE ELEMENTARY SCHOOL</b> 3 cr. (3 and 0) Specialized information concerning theory and practice of elementary school counseling; opportunity to explore elementary school counseling techniques.
EDC 802	<b>FOUNDATIONS OF SECONDARY SCHOOL COUNSELING AND GUIDANCE</b> 3 cr. (3 and 0) Counseling and guidance programs in the secondary school; principles, programs and policies underlying programs.
EDC 803	<b>STUDENT DEVELOPMENT SERVICES IN HIGHER EDUCATION</b> 3 cr. (3 and 0) Pupil personnel services offered by institutions of higher education.
EDC 804	<b>THEORIES OF STUDENT DEVELOPMENT IN HIGHER EDUCATION</b> 3 cr. (3 and 0) Developmental aspects of the young adult age group and the relationship to postsecondary schools and training programs.
EDC 805	<b>COMMUNITY AGENCY COUNSELING</b> 3 cr. (3 and 0) History and description of various counseling services provided in agency settings, the type of client populations served and existing legislative acts mandating these services; emphasis on theoretical perspectives of mental disorders, diagnostic concepts and frameworks, treatment and intervention models, and counseling theory.



- EDC 810 THEORIES AND TECHNIQUES OF COUNSELING**  
3 cr. (3 and 0)  
Counseling theories and techniques. **Prerequisite:** EDC 801, 802 or permission of instructor.
- EDC 811 MULTICULTURAL COUNSELING**  
3 cr. (3 and 0)  
Responsibility of counselors to all people regardless of race, sex, gender, socioeconomic status, subculture, etc.; content and theory related to counseling multicultural individuals/groups.
- EDC 812 CAREER COUNSELING**  
3 cr. (3 and 0)  
Gathering, interpreting and utilizing educational, social and occupational information; techniques used in placement, survey and follow-up.
- EDC 813 ANALYSIS OF THE INDIVIDUAL**  
3 cr. (2 and 2)  
Experience in gathering, interpreting and utilizing data as it relates to the individual; especially significant to counselors. **Prerequisite:** EDF 808 or permission of instructor.
- EDC 814 DEVELOPMENT OF COUNSELING SKILLS**  
3 cr. (3 and 0)  
On-campus experience to help counselors develop communication skills through role-playing activities, audio and videotaping, interviewing, lecture and discussion. **Prerequisite or Corequisite:** EDC 810.
- EDC 815 GROUP COUNSELING**  
3 cr. (3 and 0)  
Experience as a member of a group to aid the student in understanding group dynamics and the role of a group member as a participant and facilitator; emphasis is on small group participation, communication skills and self-understanding.
- EDC 816 INTRODUCTION TO MARRIAGE AND FAMILY COUNSELING**  
3 cr. (3 and 0)  
Introduction to the major models and techniques of marriage and family counseling. History research, legal, ethical and other professional issues will be surveyed as well as concepts related to family life cycle, healthy family functioning, divorce, ethnicity, problem conceptualization and non-traditional structures. **Prerequisites:** EDC 810 (corequisite) or 814 or permission of instructor.
- EDC 820 THE SCHOOL COUNSELOR AS CONSULTANT**  
3 cr. (3 and 0)  
Rationale, content and consultation process in school and nonschool settings; study of and practice in various consulting activities. **Prerequisite:** EDC 801 or permission of instructor.
- EDC 822 ADDICTIONS COUNSELING**  
3 cr. (3 and 0)  
Comprehensive overview of the phenomenon of chemical dependence and addiction; current methods of identification and intervention; and awareness of how addictions affect individuals, families, schools and communities. **Prerequisite:** Permission of instructor.
- EDC 823 ADVANCED COUNSELING TECHNIQUES AND STRATEGIES**  
3 cr. (3 and 0)  
Development of in-depth counseling skills; techniques for working with a wide variety of populations and/or problems. **Prerequisites:** EDC 810, 814, 815 and completion of 30 hours in a master's program in counseling or certification as a school counselor.
- EDC 830 ELEMENTARY SCHOOL COUNSELING PRACTICUM I**  
3 cr. (1 and 6)  
Supervised field experience in counseling and other services in an elementary school. **Prerequisite:** EDC 801, 810, 814 or permission of instructor.
- EDC 831 ELEMENTARY SCHOOL COUNSELING PRACTICUM II**  
3 cr. (1 and 6)  
Additional field experiences in counseling, consulting and coordinating services for the elementary school child. **Prerequisite:** EDC 801, 810, 814, 830 or permission of instructor.
- EDC 832 SECONDARY SCHOOL COUNSELING PRACTICUM I**  
3 cr. (1 and 6)  
Supervised field experience in counseling and other services in a secondary school setting. **Prerequisites:** EDC 810 and 814.
- EDC 833 SECONDARY SCHOOL COUNSELING PRACTICUM II**  
3 cr. (1 and 6)  
Additional field experiences in counseling, consulting and coordinating services for the secondary school student. **Prerequisites:** EDC 810, 814, 832 and 30 hours completed in the program.
- EDC 834 STUDENT AFFAIRS PRACTICUM I**  
3 cr. (1 and 6)  
Supervised field experience in counseling and other student services in a postsecondary school setting. **Prerequisite:** EDC 802, 810, 814 or permission of instructor.
- EDC 835 STUDENT AFFAIRS PRACTICUM II**  
3 cr. (1 and 6)  
Additional supervised field experience in counseling and other student services in a postsecondary setting. **Prerequisite:** EDC 810, 814, 834 or permission of instructor.
- EDC 836 COMMUNITY AGENCY COUNSELING PRACTICUM I**  
3 cr. (1 and 6)  
Supervised field experiences in counseling and other services in a community agency setting. **Prerequisite:** EDC 810, 814 or permission of instructor.



- EDC 837 COMMUNITY AGENCY COUNSELING PRACTICUM II**  
3 cr. (1 and 6)  
Additional field experiences in counseling and other agency activities. **Prerequisite:** EDC 810, 814, 836 or permission of instructor
- EDC 838 COUNSELING INTERNSHIP**  
3 cr. (1 and 6)  
A post-master's degree supervised internship in counseling; designed to provide experience in counseling as well as coordination of services for a diverse client population; the student participates in direct services with clients in an approved agency. May be repeated for a total of six hours of credit. **Prerequisite:** A master's degree in counseling or closely related field approved by program coordinator.
- EDC 840 INDEPENDENT STUDY IN COUNSELING**  
1-3 cr. (1-3 and 0)  
Individualized, in-depth study of a particular topic not offered in other courses. Reading, research and independent study are supervised by a faculty member. **Prerequisite:** Permission of instructor.
- EDC 885 SELECTED TOPICS**  
1-3 cr. (1-3 and 0)  
Developing trends in counseling that are not covered in other courses. May be repeated for 12 credits.
- EDC 915 INTERNSHIP IN A COUNSELING SETTING**  
3 cr. (1 and 6)  
A post-master's degree supervised internship in counseling designed to provide experience in counseling as well as coordination of service for a diverse client population; participation in direct services with clients in an approved agency. May be repeated for a total of six hours of credit. **Prerequisite:** Master's degree in counseling or a closely related field approved by program coordinator.
- EDC 920 COUNSELOR SUPERVISION**  
3 cr. (3 and 0)  
Overview of conceptual and empirical literature on counselor supervision that includes models, approaches, techniques, relationship/process issues, legal concerns and ethical considerations; develop supervision skills through readings, seminar discussions and supervision of master's level students. **Prerequisite:** Master's degree in counseling or related area or permission of instructor.
- EDL 700 PUBLIC SCHOOL ADMINISTRATION**  
3 cr. (3 and 0)  
Theoretical bases of school administration; organizational principles, patterns and practices in public schools; decision making; administration of programs and services. **Prerequisite:** Three graduate education courses or permission of instructor.
- EDL 705 THE PRINCIPALSHIP**  
3 cr. (3 and 0)  
Roles and responsibilities of the principalship, including the organization and administration of schools.
- EDL 710 ORGANIZATIONAL THEORY FOR SCHOOL ADMINISTRATORS**  
3 cr. (3 and 0)  
Theory of management, communication, human relations, social systems, motivation, contingency, decision making and change. **Prerequisite:** EDL 700.
- EDL 715 SCHOOL AND COMMUNITY RELATIONSHIPS**  
3 cr. (3 and 0)  
Interdependence of school and community; identifying and defining societal expectations of schools and effect of these expectations on educational policy; impact of social, political, economic and demographic change on educational policy.
- EDL 720 SCHOOL PERSONNEL ADMINISTRATION**  
3 cr. (3 and 0)  
School personnel selection, practices and problems. **Prerequisites:** EDL 700 and 705.
- EDL 725 LEGAL PHASES OF SCHOOL ADMINISTRATION**  
3 cr. (3 and 0)  
Legal principles involved in school administration and in court actions. **Prerequisites:** EDL 700 and 710.
- EDL 730 TECHNIQUES OF SUPERVISION — THE PUBLIC SCHOOLS**  
3 cr. (3 and 0)  
Improving, coordinating and evaluating instruction; modern trends of supervisory practices. **Prerequisites:** EDL 700 and 710.
- EDL 735 EDUCATIONAL EVALUATION**  
3 cr. (3 and 0)  
Evaluation theory and design applied to classroom instruction and to evaluation procedures applicable to school center and district programs and projects. **Prerequisites:** EDL 700 and 710.
- EDL 740 CURRICULUM PLANNING AND IMPROVEMENT FOR SCHOOL ADMINISTRATORS**  
3 cr. (3 and 0)  
Role of leadership in curriculum planning and improvement: curriculum evaluation and development, change, programmatic requirements, co-curriculum, organization, scheduling, planning, management and technology. **Prerequisites:** EDL 700 and 710.
- EDL 745 SCHOOL FINANCE**  
3 cr. (3 and 0)  
School finance relative to programs, revenues and experience. **Prerequisites:** EDL 700 and 735.



- EDL 750** **FIELD EXPERIENCE IN ELEMENTARY ADMINISTRATION AND SUPERVISION**  
3 cr. (1 and 4)  
Practicum with an experienced elementary administrator or supervisor. May be repeated for a maximum of six credits. **Prerequisites:** EDL 700 and 710.
- EDL 755** **FIELD EXPERIENCE IN SECONDARY ADMINISTRATION AND SUPERVISION**  
3 cr. (1 and 4)  
Practicum with an experienced secondary administrator or supervisor. May be repeated for a maximum of six credits. **Prerequisites:** EDL 700 and 710.
- EDL 760** **PROGRAM ADMINISTRATION AND LEADERSHIP IN HIGHER EDUCATION**  
3 cr. (3 and 0)  
Process of organizing the personnel and financial resources needed to meet effectively student development and institutional goals and objectives. **Prerequisite:** Permission of instructor.
- EDL 762** **THE AMERICAN COLLEGE STUDENT**  
3 cr. (3 and 0)  
How college students change and develop and how college can enhance that development.
- EDL 764** **THEORETICAL AND PRACTICAL APPLICATION OF STUDENT DEVELOPMENT AND LEADERSHIP IN A UNIVERSITY SETTING**  
3 cr. (3 and 0)  
Leadership, programming, problem-solving, conflict resolution, confrontation and referral skills; legal and ethical issues and the implications for practitioners; comparative studies of housing programs and utilization of resources and support services.
- EDL 765** **ASSESSMENT IN HIGHER EDUCATION**  
3 cr. (3 and 0)  
Outcomes assessment and institutional effectiveness movement including assessment techniques, instrument selection, analysis of assessment data and reporting of assessment findings. **Prerequisite:** Permission of instructor.
- EDL 795** **LEADERSHIP INFORMATION SYSTEMS FOR SCHOOL ADMINISTRATORS**  
3 cr. (2 and 2)  
Use of computers and related technologies for decision making by public school leaders; logistics of information management, sources of information, communication with technology and integration of technology into the leadership function.
- EDL 800** **PHILOSOPHY, SCHOOLING AND EDUCATIONAL POLICY**  
3 cr. (3 and 0)  
Analysis of the development of contemporary educational theory and its impact on current schooling practices and educational policy development.
- EDL 805** **ADVANCED EDUCATIONAL LEADERSHIP: THEORY AND PRACTICE**  
3 cr. (3 and 0)  
Accepted principles and theories of leadership as practiced in the institutional setting. **Prerequisites:** EDL 700, 715 and 730.
- EDL 810** **INTRODUCTION TO SCHOOL BUILDING PLANNING**  
3 cr. (2 and 2)  
Planning of educational facilities from conception of need through utilization of facility. **Prerequisite:** EDL 700.
- EDL 815** **THE SUPERINTENDENCY**  
3 cr. (3 and 0)  
Current, in-depth study of the superintendency, including relationships with school boards, faculty, staff and community, for practicing and aspiring educational administrators. **Prerequisite:** Admission to the educational specialist program or the doctoral program.
- EDL 820** **POLITICS OF EDUCATION**  
3 cr. (3 and 0)  
Politics of education in the United States, including the complex interrelationships among administrators, special interest groups, politicians and knowledge brokers.
- EDL 830** **BUSINESS MANAGEMENT IN EDUCATION**  
3 cr. (2 and 3)  
Fiscal management of individual schools and districts, including budgeting, purchasing and accounting for funds. **Prerequisites:** EDL 700, 725 and 745.
- EDL 839** **RESEARCH METHODS IN EDUCATIONAL LEADERSHIP**  
3 cr. (3 and 0)  
Introductory course for development of the design, method and procedures for conducting the Educational Specialist Project; culmination of the course is the completion and presentation of the project prospectus for approval by the instructor and the student's major advisor. Graded on a pass/fail basis. **Prerequisites:** EDL 800, 805, 820 and permission of instructor.
- EDL 840** **FIELD PROBLEMS IN SCHOOL ADMINISTRATION AND SUPERVISION OF INSTRUCTION**  
3 cr. (2 and 3)  
Application of research techniques and practices in solution of field problems in school administration and supervision. **Prerequisites:** EDL 700 and EDF 778.
- EDL 850** **PRACTICUM IN SCHOOL SYSTEM ADMINISTRATION AND SUPERVISION**  
3 cr. (1 and 4)  
Practicum with an experienced school-system-level administrator or supervisor. May be repeated for a maximum of six credits. **Prerequisites:** EDL 800, 805 and permission of instructor.



- EDL 855 APPLIED RESEARCH AND EVALUATION IN HIGHER EDUCATION**  
3 cr. (3 and 0)  
Basic issues of measurement emphasizing questionnaire development, scales and measures commonly used in higher education research, assessment and program evaluation.
- EDL 885 SELECTED TOPICS IN EDUCATIONAL ADMINISTRATION**  
1-3 cr. (1-3 and 0)  
Current literature and results of current research. Topics vary from year to year. May be repeated for a maximum of six credits.
- EDL 890 POLICY AND MANAGEMENT OF SCHOOL DISCIPLINE**  
3 cr. (3 and 0)  
Theory and practice involved in student management and discipline in today's schools, particularly preventative management, organizational variables and today's litigious environment. **Prerequisite:** Permission of instructor.
- EDL 900 PRINCIPLES OF EDUCATIONAL LEADERSHIP**  
3 cr. (3 and 0)  
Advanced leadership theory; the nature of leadership, major theories of leadership, and their application in educational organizations. **Prerequisite:** Must have passed the preliminary examination in the Ph.D. program in educational leadership.
- EDL 905 THEORY AND PRACTICE IN EDUCATIONAL LEADERSHIP**  
3 cr. (3 and 0)  
Advanced organizational and leadership theory; major theories of organization and their applications in understanding the roles of governmental agencies in society. **Prerequisite:** Admission to the doctoral program.
- EDL 910 INTRODUCTORY DOCTORAL SEMINAR**  
3 cr. (3 and 0)  
Educational leadership for beginning doctoral students providing an introduction to the conceptual and theoretical frameworks of educational leadership for both public school administration and higher education administration. **Prerequisite:** Permission of instructor.
- EDL 915 EDUCATIONAL PLANNING**  
3 cr. (3 and 0)  
Education planning, the mechanics of the total planning process, the systems approach to planning and management, and the measurement and interpretation of performance results.
- EDL 925 INSTRUCTIONAL LEADERSHIP**  
3 cr. (3 and 0)  
Preparation for a career in educational leadership; the principal's functions regarding the effective school's movement as incorporated in instructional leadership.
- EDL 930 COMPLEX ORGANIZATIONS AT THE EDGE OF CHAOS**  
3 cr. (3 and 0)  
Formal and informal social organization relative to recent advances in chaos and complexity theories. Topics include chaos and complexity theory, organizational theory, philosophical premises, network analysis, mathematical modeling, artificial life simulations, game theory, catastrophe theory, social evolution, social morphology and nonlinear theories of social organization. **Prerequisite:** One graduate level organizational theory course or permission of instructor.
- EDL 940 ADVANCED DESIGN AND ANALYSIS OF RESEARCH IN EDUCATIONAL LEADERSHIP**  
3 cr. (2 and 2)  
A cumulative research course for Ph.D. students in educational leadership; emphasizes conceptual understanding of field research strategies, design qualitative studies and independence as a researcher. **Prerequisite:** Advanced Research and Statistics.
- EDL 950 EDUCATIONAL POLICY STUDIES**  
3 cr. (3 and 0)  
Critical analysis of the sources and nature of educational policy and how policy is developed, administered and assessed for public schools. **Prerequisite:** Admission to doctoral studies.
- EDL 955 THE TWO-YEAR COLLEGE**  
(VT ED 955) 3 cr. (3 and 0)  
Historical developments, functions, organization and administration of the two-year college. **Prerequisite:** Admission to doctoral studies or permission of instructor.
- EDL 960 LEGAL PRINCIPLES IN THE ADMINISTRATION OF INSTITUTIONS OF HIGHER EDUCATION**  
3 cr. (3 and 0)  
General principles of higher education law from the points of view of statute and common law practice. **Prerequisite:** Admission to doctoral studies or permission of instructor.
- EDL 965 HIGHER EDUCATION FINANCE**  
3 cr. (3 and 0)  
Higher education finance relative to sources of revenue, expenditures and planning.
- EDL 970 FOUNDATIONS OF HIGHER EDUCATION**  
3 cr. (3 and 0)  
Survey of American higher education including its historical, political, philosophical and social aspects. **Prerequisite:** Admission to doctoral studies.
- EDL 972 ETHICS IN EDUCATIONAL LEADERSHIP**  
3 cr. (3 and 0)  
Ethical issues involved in administering educational institutions; moral leadership, ethical work environments and decision making models.



- EDL 976 EXTERNAL EFFECTIVENESS IN HIGHER EDUCATION**  
3 cr. (3 and 0)  
Optimum structures and strategies for fundraising, public relations, constituent relations, governmental affairs and governing boards necessary for a college or university to communicate effectively with its constituents.
- EDL 980 CURRENT ISSUES IN EDUCATIONAL LEADERSHIP**  
1-3 cr. (1-3 and 0)  
Topics and issues as determined by the needs of the students and the instructor. **Prerequisites:** Graduate status and permission of instructor.
- EDL 985 INTERNSHIP IN EDUCATIONAL LEADERSHIP**  
3 cr. (1 and 4)  
Experience working in a chosen area of specialization in educational leadership, either in public schools or institutions of higher education; experience planned to build competence in the student's field of specialization. May be repeated for a maximum of six credits. Graded on a pass/fail basis. **Prerequisites:** EDL 900, 905 and 910 and permission of the student's major advisor.
- EDL 989 ADVANCED DOCTORAL SEMINAR I**  
3 cr. (3 and 0)  
Exploration of educational leadership topics; culminates in the selection of a topic for presentation and approval, and the development of Chapter I of a prospectus. Graded on a pass/fail basis. **Prerequisites:** EDL 900, 905, 910 and permission of the instructor.
- EDL 990 ADVANCED DOCTORAL SEMINAR II**  
3 cr. (3 and 0)  
Seminar for advanced students, focusing on the preparation of dissertation Chapters I-III.
- EDL 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.
- EDL 995 DIRECTED RESEARCH**  
1-4 cr. (1-4 and 0)  
Research option for graduate students to pursue a line of inquiry in education under the direction of faculty; specific educational question is investigated and reported using appropriate methodology. Graded on a pass/fail basis. May be repeated for a total of four hours. **Prerequisite:** Admission to doctoral studies or permission of instructor.

## Curriculum and Instruction

Robert P. Green, Chair, Department of Curriculum and Instruction

Majors	Degrees
Curriculum and Instruction	Ph.D.
Elementary Education	M.Ed.
Reading	M.Ed.
Secondary Education	M.Ed.

The Doctor of Philosophy degree in curriculum and instruction requires a minimum of 70 semester hours beyond the master's degree, selected from the areas prescribed by the Department of

Curriculum and Instruction. Admission requirements include a master's degree and appropriate GRE scores.

Students seeking admission to the Master of Education degree programs with majors in elementary education, reading and secondary education should have a valid professional teacher's certificate on the appropriate level.

A major in elementary education is offered to teachers who hold professional early childhood or elementary certificates. The 36 hours and courses may be selected from six areas as prescribed by the Department of Curriculum and Instruction.

A major in reading is offered for reading specialists, consultants and/or supervisors. The 36 semester hours are prescribed by the Department of Curriculum and Instruction.

A major in secondary education is offered to high school or prospective junior college teachers in the subject areas of English, history and government, mathematics and natural sciences. Candidates are required to complete a minimum of 15 semester hours in graduate courses in education and a minimum of 18 hours in graduate courses in the content area. A total of 36 semester hours is required.

- ED 631 SPECIAL INSTITUTE COURSE: EARLY CHILDHOOD EDUCATION**  
1-3 cr. (1-3 and 0)
- ED 632 SPECIAL INSTITUTE COURSE: ELEMENTARY SCHOOL**  
1-3 cr. (1-3 and 0)
- ED 633 SPECIAL INSTITUTE COURSE: SECONDARY SCHOOL**  
1-3 cr. (1-3 and 0)
- ED 634 SPECIAL INSTITUTE COURSE FOR COMPARATIVE STUDIES IN EDUCATION**  
1-3 cr. (1-3 and 0)
- ED 635 SPECIAL INSTITUTE COURSE: CURRICULUM**  
1-3 cr. (1-3 and 0)
- ED 640 ADVANCED PHYSICAL EDUCATION METHODS OF THE CLASSROOM TEACHER**  
3 cr. (3 and 0)
- ED 641 MIDDLE SCHOOL CURRICULUM**  
3 cr. (3 and 0)
- ED 700 SUPERVISING THE STUDENT TEACHER IN THE PUBLIC SCHOOL**  
(IN ED 700)  
2-3 cr. (2-3 and 0)  
Knowledge and skills desirable for supervisors of student teachers; use of observation instruments for recording objective data and evaluating teaching performance is explored. Graded on a pass/fail basis. **Prerequisites:** A professional teaching certificate, at least one year of teaching experience, a recommendation from the employing school district or consent of the instructor.
- ED 740 CURRICULUM PLANNING FOR EARLY CHILDHOOD EDUCATION**  
3 cr. (3 and 0)  
Introduction to early childhood education (ages five through eight); the nature of learning and its bearing upon curriculum; early childhood curriculum content. **Prerequisite:** Permission of instructor.



- ED 759 FUNDAMENTALS OF BASIC READING**  
3 cr. (3 and 0)  
Historical progression of the teaching of reading; current theories and reading practices; teaching basic reading skills.
- ED 760 CURRICULUM DEVELOPMENT IN THE ELEMENTARY SCHOOL**  
3 cr. (3 and 0)  
Curriculum planning practices in the elementary school.
- ED 761 READING INSTRUCTION IN THE ELEMENTARY SCHOOL**  
3 cr. (3 and 0)  
Knowledge and skills necessary for teaching reading to varied types of elementary school learners.
- ED 762 READING DIAGNOSIS AND REMEDIATION**  
3 cr. (2 and 3)  
Remedial methods and materials for teaching reading; use of diagnostic instruments and interpretation of test results. Student participates in laboratory/field experience and prepares case study with summary of diagnosis emphasizing remediation procedures. **Prerequisite:** Three semester hours in reading or permission of instructor.
- ED 763 MIDDLE SCHOOL READING**  
3 cr. (3 and 0)  
Techniques, materials and theories for teaching reading to middle school students, emphasizing correlating reading skills into the content area. **Prerequisite:** Education major or permission of instructor.
- ED 764 THE ROLE OF THE LIBRARY IN THE READING PROGRAM**  
3 cr. (3 and 0)  
Prepares librarians to work with teachers and pupils, and prepares teachers to work with librarians and pupils in the reading program. **Prerequisite:** Employment as a teacher or librarian and/or permission of instructor.
- ED 765 SECONDARY SCHOOL CURRICULUM**  
3 cr. (3 and 0)  
Principles, techniques and trends in secondary school curriculum development and evaluation. **Prerequisite:** Graduate status.
- ED 780 THE WHOLE LANGUAGE APPROACH TO READING AND WRITING**  
3 cr. (3 and 0)  
Understanding of the reading/writing processes for early childhood and elementary teachers; investigation of the whole language approach in the classroom. **Prerequisite:** ED 759 or equivalent.
- ED 798 TEACHING SECONDARY SCHOOL READING**  
3 cr. (3 and 0)  
Methods and materials for secondary reading programs in developmental, corrective, remedial, adapted, content and recreational areas.
- ED 803 ADVANCED METHODS OF TEACHING IN THE SECONDARY SCHOOL**  
3 cr. (3 and 0)  
Principles and practices involved in promoting effective learning in secondary schools.
- ED 804 ADVANCED METHODS OF TEACHING IN THE ELEMENTARY SCHOOL**  
3 cr. (3 and 0)  
Principles and practices involved in promoting effective learning in elementary schools; analysis and evaluation of educational media.
- ED 820 TEACHING LANGUAGE ARTS TO THE EXCEPTIONAL CHILD**  
3 cr. (3 and 0)  
Various approaches to teaching listening, writing, reading and speaking skills to the exceptional child.
- ED 837 ADVANCED METHODS IN ELEMENTARY SCIENCE**  
3 cr. (3 and 0)  
Current research and trends in elementary science teaching methods and curriculum development; students examine recent literature and proposed standards for science teaching and develop strategies to implement recommended practices in their own classrooms. **Prerequisite:** Elementary teaching experience.
- ED 840 PROGRAM DEVELOPMENT AND IMPLEMENTATION IN EARLY CHILDHOOD EDUCATION**  
3 cr. (2 and 2)  
Current issues in early childhood curriculum, their sources and the beliefs supporting them; design of a modified curriculum for a specific content area and level; for graduate students with teaching experience. **Prerequisites:** ED 701 and 740, relevant teaching experience, or permission of instructor.
- ED 841 ADVANCED STUDIES IN THE TEACHING OF SECONDARY SCHOOL ENGLISH**  
3 cr. (3 and 0)  
Methods of teaching secondary school English, based on research and review of current literature.
- ED 842 ADVANCED STUDIES IN THE TEACHING OF SECONDARY SCHOOL MATHEMATICS**  
3 cr. (3 and 0)  
Mathematics education history, research in mathematics education, knowledge of the learner, instructional strategies, materials management and evaluation. **Prerequisite:** ED 426 or permission of instructor.
- ED 843 ADVANCED STUDIES IN THE TEACHING OF SECONDARY SCHOOL SCIENCE**  
3 cr. (3 and 0)  
Methods of science teaching theory and practice as shown by current research literature; emphasis on laboratory, inquiry and other student-centered teaching strategies; techniques in science curriculum development; issues in science teaching; science teaching leadership skills. **Prerequisite:** ED 427 or permission of instructor.



- ED 844**      **ADVANCED STUDIES IN THE TEACHING OF SECONDARY SCHOOL SOCIAL STUDIES**  
3 cr. (3 and 0)  
Social studies teaching strategies derived from major theories of learning and contemporary research; curricular issues in social studies education. **Prerequisite:** ED 428 or permission of instructor.
- ED 846**      **THE CURRENT LITERATURE IN ENGLISH EDUCATION**  
3 cr. (3 and 0)  
Research literature in English education; an examination of literature in research methods and curriculum in English teaching. **Prerequisite:** A methods course in English education.
- ED 847**      **THE CURRENT LITERATURE IN MATHEMATICS TEACHING**  
3 cr. (3 and 0)  
Recent literature of mathematics education; examination of literature in both the research and curriculum in secondary mathematics teaching. **Prerequisite:** A graduate teaching methods course or permission of instructor.
- ED 848**      **THE CURRENT LITERATURE IN SCIENCE TEACHING**  
3 cr. (3 and 0)  
Recent literature of science education; examination of literature in both the research and curriculum in secondary science teaching. **Prerequisite:** A graduate teaching methods course or permission of instructor.
- ED 849**      **THE CURRENT LITERATURE IN SOCIAL STUDIES TEACHING**  
3 cr. (3 and 0)  
Recent literature in social studies education; literature in both curriculum and instruction is considered. **Prerequisite:** A graduate teaching methods course or permission of instructor.
- ED 854**      **APPLIED BEHAVIOR ANALYSIS**  
3 cr. (3 and 0)  
Principles underlying behavioral development and application of the principles of behavior analysis to solving academic and social problems of youth with disabilities in classroom settings. **Prerequisites:** Graduate standing and ED 671 or equivalent.
- ED 861**      **ORGANIZATION AND SUPERVISION OF READING PROGRAMS**  
3 cr. (3 and 0)  
Supervisory problems with planning reading programs; analysis of methods and materials of teaching; evaluation of reading programs. **Prerequisite:** ED 762.
- ED 862**      **CLINICAL RESEARCH IN READING**  
3 cr. (3 and 0)  
Reading research and literature; original investigation in such problems as development of reading skills and attitudes, clinical procedures and techniques required. **Prerequisite:** ED 762.
- ED 863**      **PRACTICUM IN READING**  
3 cr. (2 and 2)  
Supervised practicum emphasizing diagnostic and remedial work with readers in public schools. **Prerequisites:** ED 762 and permission of instructor.
- ED 864**      **SPECIAL PROBLEMS IN READING EDUCATION**  
3 cr. (1 and 4)  
Individual study of a specific topic in reading; student is allowed to study a large diversity of topics. **Prerequisites:** ED 759 or 761; and ED 762, 808 and 862; or permission of instructor.
- ED 865**      **ADVANCED DIAGNOSIS AND REMEDIATION IN READING**  
3 cr. (2 and 3)  
Advanced diagnosis and remediation in reading; review of diagnostic instruments and instructional materials. **Prerequisites:** ED 759 or 761 and 762, and/or permission of instructor.
- ED 866**      **THE PSYCHOLOGY OF TEACHING READING**  
3 cr. (3 and 0)  
Psychological basis of reading process; principles applied in teaching reading. **Prerequisite:** ED 759, 761 or permission of instructor.
- ED 867**      **ADVANCED PRACTICUM IN READING**  
3 cr. (2 and 3)  
Diagnosis and remediation testing; remediation; extensive case studies with recommendation for the classroom teacher required. **Prerequisites:** ED 865 and permission of instructor.
- ED 868**      **TEACHING READING THROUGH A LITERATURE EMPHASIS**  
3 cr. (3 and 0)  
Strategies for integrating literature into the traditional reading program. **Prerequisite:** An introductory reading class or equivalent.
- ED 869**      **THE READING-WRITING CONNECTION: AN INTEGRATED APPROACH**  
3 cr. (3 and 0)  
Theoretical bases and practical techniques for teaching reading and writing in an integrated manner; reading and writing as processes; basic skills instruction in a coordinated program; multiple subject areas; use of student interest and ability. **Prerequisite:** Basic reading methods course.
- ED 889**      **RESEARCH IN EDUCATION**  
(IN ED 889)      3 cr. (3 and 0)  
(AG ED 889)      See AG ED 889 for description.
- ED 891**      **MASTER'S THESIS RESEARCH**  
Credit to be arranged.  
Student participates in a new or existing research project with a faculty member; develops basic skills in a selected research methodology. **Prerequisite:** Advanced methods course, ED 889, EDF 808 or permission of instructor.



- ED 894 DIRECTED RESEARCH**  
1-4 cr. (1-4 and 0)  
Research in a line of inquiry in education under the direction of faculty; a specific educational question is investigated and reported using appropriate methodology. Graded on a pass/fail basis. **Prerequisite:** EDF 778, 808 or permission of instructor.
- ED 937 DESIGNING ELEMENTARY CURRICULUM**  
3 cr. (3 and 0)  
Theoretical issues and guidelines for educators engaged in the curriculum development process at the elementary level. **Prerequisite:** Admission to the Ph.D. program in curriculum and instruction.
- ED 954 CURRICULUM THEORY**  
3 cr. (3 and 0)  
Main currents of curriculum theory in American education. **Prerequisite:** Ed 760 or 765.
- ED 955 THEORETICAL BASES OF INSTRUCTION**  
3 cr. (3 and 0)  
Seminar in the application of learning theory to instructional practice, emphasizing instructional strategies in the classroom. **Prerequisite:** ED 702.
- ED 980 INTERNSHIP IN CURRICULUM AND INSTRUCTION**  
1-6 cr. (0 and 3-18)  
Practical experiences linking the student's program of study to his or her field of professional service. Graded on a pass/fail basis. **Prerequisite:** Permission of the student's major advisor.
- ED 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

*The following courses in coaching education are offered by the Department of Curriculum and Instruction for recertification or as electives.*

- C ED 653 ATHLETIC INJURIES: PREVENTION, ASSESSMENT AND REHABILITATION**  
3 cr. (3 and 0)
- C ED 721 SPORT LAW**  
3 cr. (3 and 0)  
Legal principles involved in school sports programs and in court action. **Prerequisites:** C ED 761 and three graduate courses in C ED or permission of instructor.
- C ED 751 PHYSIOLOGY OF TRAINING THE ATHLETE**  
3 cr. (3 and 0)  
Specific sport skill training; emphasis is on the design of exercise programs for the particular sport.
- C ED 752 ADVANCED SKILL ANALYSIS IN SPORTS**  
3 cr. (3 and 0)  
Application of the basic laws of physics to human movement; student uses videotapes to break down sports skill and make recommendations for improvement.

- C ED 761 ORGANIZATION AND ADMINISTRATION OF PHYSICAL EDUCATION AND ATHLETIC PROGRAMS**  
3 cr. (3 and 0)  
Policies and procedures of administration on the secondary and collegiate levels; special emphasis on construction and care of facilities, equipment and personnel.
- C ED 762 PSYCHOLOGICAL BASIS OF COACHING**  
3 cr. (3 and 0)  
Psychological theory and techniques that enhance the performance and personal growth of athletes from youth sports to the elite levels.
- C ED 765 PRACTICUM I IN COACHING EDUCATION**  
3 cr. (1 and 6)  
Application of theoretical concepts in real athletic/sports administration situations for coaches. **Prerequisites:** C ED 751 and 761, EDF 778 and permission of instructor.
- C ED 766 PRACTICUM II IN COACHING EDUCATION**  
3 cr. (1 and 6)  
Application of theoretical concepts in real athletic/sports administration situations for coaches. **Prerequisites:** C ED 751, 761 and 765, EDF 778 and permission of instructor.

*The following courses are applicable only to the Master of Education degree with emphasis in the specific subject areas. Descriptions are under the respective departmental headings.*

#### English

C. Harold Woodell, Advisor

- ENGL 700 CHILDREN'S LITERATURE FOR TEACHERS**  
3 cr. (3 and 0)
- ENGL 701 LITERATURE FOR TEACHERS**  
3 cr. (3 and 0)
- ENGL 702 WRITING PROJECTS**  
3 cr. (3 and 0)

#### History and Government

Edwin E. Moise, Advisor

- ECON 750 ECONOMIC CONCEPTS AND CLASSROOM APPLICATIONS FOR TEACHERS**  
3 cr. (3 and 0)
- ECON 751 SELECTED TOPICS FOR TEACHERS**  
3 cr. (3 and 0)
- GEOG 700 TOPICS IN GEOGRAPHY**  
3 cr. (3 and 0)
- GEOG 710 GEOGRAPHY FOR TEACHERS**  
3 cr. (3 and 0)
- HIST 700 UNITED STATES THROUGH THE CIVIL WAR**  
3 cr. (3 and 0)
- HIST 710 UNITED STATES SINCE 1865**  
3 cr. (3 and 0)
- HIST 720 SOUTHERN HISTORY**  
3 cr. (3 and 0)



- HIST 760**      **BRITISH HISTORY**  
3 cr. (3 and 0)
- HIST 770**      **EUROPE TO THE 18TH CENTURY**  
3 cr. (3 and 0)
- HIST 775**      **EUROPE SINCE THE 18TH CENTURY**  
3 cr. (3 and 0)
- HIST 790**      **HISTORICAL AREA STUDIES**  
3 cr. (3 and 0)

**Mathematics**

William R. Hare, Advisor

- MTHSC 700**      **MATHEMATICAL COMPUTER APPLICATIONS FOR ELEMENTARY TEACHERS**  
3 cr. (3 and 0)
- MTHSC 703**      **MODERN MATHEMATICS FOR ELEMENTARY SCHOOL TEACHERS — GEOMETRY**  
3 cr. (3 and 0)
- MTHSC 707**      **MATHEMATICS FOR MIDDLE SCHOOL TEACHERS — ALGEBRA**  
3 cr. (3 and 0)
- MTHSC 709**      **MATHEMATICS FOR MIDDLE SCHOOL TEACHERS — GEOMETRY**  
3 cr. (3 and 0)
- MTHSC 710**      **ELEMENTARY CALCULUS FROM AN ADVANCED VIEWPOINT I**  
3 cr. (3 and 0)
- MTHSC 711**      **ELEMENTARY CALCULUS FROM AN ADVANCED VIEWPOINT II**  
3 cr. (3 and 0)
- MTHSC 712**      **MODERN ALGEBRAIC CONCEPTS**  
3 cr. (3 and 0)
- MTHSC 719**      **DISCRETE MATHEMATICS**  
3 cr. (3 and 0)
- MTHSC 721**      **MATRIX ALGEBRA**  
3 cr. (3 and 0)
- MTHSC 723**      **APPLICATIONS OF LINEAR AND MODERN ALGEBRA**  
3 cr. (3 and 0)
- MTHSC 725**      **COMBINATORIAL MATHEMATICS FOR TEACHERS**  
3 cr. (3 and 0)
- MTHSC 727**      **ANALYSIS CONCEPTS FOR TEACHERS**  
3 cr. (3 and 0)
- MTHSC 730**      **MODERN GEOMETRY FOR TEACHERS**  
3 cr. (3 and 0)
- MTHSC 732**      **PROJECTIVE GEOMETRY**  
3 cr. (3 and 0)
- MTHSC 741**      **INTRODUCTION TO LINEAR PROGRAMMING WITH APPLICATIONS**  
3 cr. (3 and 0)

- MTHSC 751**      **FUNDAMENTAL CONCEPTS OF CALCULUS**  
3 cr. (3 and 0)
- MTHSC 761**      **PROBABILITY AND STATISTICS FOR TEACHERS**  
3 cr. (3 and 0)
- MTHSC 771**      **NUMERICAL METHODS IN SECONDARY SCHOOL MATHEMATICS**  
3 cr. (3 and 0)
- MTHSC 783**      **THEORY OF NUMBERS**  
3 cr. (3 and 0)
- MTHSC 791**      **SELECTED TOPICS IN MATHEMATICS EDUCATION**  
1-3 cr. (1-3 and 0)

**Natural Sciences**

John E. Fairey, Advisor

- AGRON 701**      **SOILS AND MAN**  
3 cr. (3 and 0)
- W F B 712**      **WILDLIFE CONSERVATION FOR TEACHERS**  
2-3 cr. (2-3 and 0)
- W F B 716**      **BIOLOGY OF FISHES FOR TEACHERS**  
3 cr. (3 and 0) SS
- BIOL 710**      **SELECTED TOPICS FOR TEACHERS**  
1-6 cr. (0-6 and 0-18)
- CH 700**      **PHYSICAL SCIENCE IN ELEMENTARY SCHOOL — CHEMISTRY**  
3 cr. (2 and 3) N
- ENT 700**      **ENTOMOLOGY FOR TEACHERS**  
3 cr. (2 and 2) SS
- GEN 701**      **MODERN DEVELOPMENTS IN GENETICS**  
3 cr. (3 and 0)
- GEOL 700**      **GEOLOGY FOR SCIENCE TEACHERS**  
3 cr. (2 and 3)
- GEOL 740**      **EARTH/SPACE SCIENCE FOR ELEMENTARY SCHOOL TEACHERS**  
3 cr. (2 and 3)
- GEOL 790**      **SELECTED TOPICS IN EARTH SCIENCES**  
1-6 cr. (0-6 and 0-18)
- HORT 701**      **HORTICULTURE: PLANT AND ENVIRONMENTAL SCIENCE**  
3 cr. (2 and 3) SS
- NUTR 706**      **NUTRITION FOR TEACHERS**  
3 cr. (3 and 0) SS
- PHYS 710**      **SELECTED TOPICS FOR TEACHERS**  
1-6 cr. (0-6 and 0-18)



## Foundations and Special Education

William R. Fisk, Chair, Department of Foundations and Special Education

**Major**  
Special Education

**Degree**  
M.Ed.

Students seeking admission to the Master of Education degree program with a major in special education should have a valid professional teacher's certificate on the appropriate level.

A major in special education is offered to those desiring specialization in the areas of mental retardation, emotional handicaps and learning disabilities. Appropriate certification is a prerequisite for admission. The 36 hours and courses are prescribed by the Department of Foundations and Special Education.

- |   |  |
|---|--|
| <b>EDF 615</b><br>(PRTM 615)                | <b>METHODS IN REDUCING RISKS FOR MIDDLE CHILDHOOD</b><br>3 cr. (2 and 3)   |
| <b>EDF 680</b><br>(AG ED 680)<br>(THRD 680) | <b>EDUCATIONAL APPLICATIONS OF MICROCOMPUTERS</b><br>3 cr. (2 and 2)   |
| <b>EDF 682</b><br>(AG ED 682)<br>(THRD 682) | <b>ADVANCED EDUCATIONAL APPLICATIONS OF MICROCOMPUTERS</b><br>3 cr. (2 and 2)  |
| <b>EDF 690</b>                              | <b>STUDENT MANAGEMENT AND DISCIPLINE</b><br>3 cr. (3 and 0)  |
| <b>EDF 697</b>                              | <b>INSTRUCTIONAL MEDIA IN THE CLASSROOM</b><br>3 cr. (3 and 0)   |
| <b>EDF 701</b>                              | <b>HUMAN GROWTH AND DEVELOPMENT</b><br>3 cr. (3 and 0)<br>Theory and research in human development and its impact on the teaching/learning process. <b>Prerequisites:</b> ED 334, 335, 336 or equivalent; classroom teaching experience.   |
| <b>EDF 702</b>                              | <b>ADVANCED EDUCATIONAL PSYCHOLOGY</b><br>3 cr. (3 and 0)<br>Educational applications of research and theory on objectives, motivation, class climate, class management and learning theory. <b>Prerequisite:</b> ED 302 or equivalent; classroom teaching experience recommended.   |
| <b>EDF 766</b>                              | <b>INTEGRATING SERVICE LEARNING INTO CURRICULUM</b><br>3 cr. (2 and 3)<br>Opportunities for certified teachers to build competence in service learning through personal participation in service and in reflection; students develop a plan to integrate service learning activities into the curriculum of their school and/or district; designed for 12-25 elementary, middle-school, high-school and adult-education teachers. <b>Prerequisite:</b> Teaching certification. |
| <b>EDF 778</b>                              | <b>EXPERIMENTAL AND NONEXPERIMENTAL RESEARCH METHODS IN EDUCATION I</b><br>3 cr. (3 and 0)<br>Types of educational research and uses; logical bases of quantitative and qualitative analysis techniques; basic research issues important in education; educational research design and procedures; introduction to measurement and   |

evaluation; applications to special problems in classroom settings and program development; and evaluation in curriculum, administration and educational support services. **Prerequisite:** EX ST 301 or equivalent or permission of instructor; EDF 808 recommended.

- |                |  |
|----------------|--|
| <b>EDF 808</b> | <b>EDUCATIONAL TESTS AND MEASUREMENTS</b><br>3 cr. (3 and 0)<br>Construction, use and interpretation of subjective and standard tests; measurement applications.   |
| <b>EDF 870</b> | <b>SCHOOLING AS A CULTURAL PROCESS</b><br>3 cr. (3 and 0)<br>Critical analysis of the interdependence of schooling and culture. <b>Prerequisite:</b> Graduate standing.  |
| <b>EDF 872</b> | <b>HISTORY OF AMERICAN EDUCATION</b><br>3 cr. (3 and 0)<br>Analysis of the historical development of educational purpose and the social and cultural forces which shaped that development. <b>Prerequisite:</b> Graduate standing.   |
| <b>EDF 875</b> | <b>SEMINAR IN HUMAN GROWTH AND DEVELOPMENT</b><br>3 cr. (3 and 0)<br>Selected topics in human development from any area of the life span; development topics examined for their impacts on the teaching/learning process, administrative processes and/or counseling approaches. <b>Prerequisites:</b> EDF 701 or equivalent and teaching, counseling or administrative experience.  |
| <b>EDF 876</b> | <b>SEMINAR IN LEARNING THEORY AND ENVIRONMENTS</b><br>3 cr. (3 and 0)<br>Selected topics in learning theory and variables affecting learning environments. Topics vary with student interests and needs and for their impacts on the teaching/learning process, administrative processes and/or counseling approaches. <b>Prerequisites:</b> EDF 702 or equivalent and classroom, counseling or administrative experience.   |
| <b>EDF 878</b> | <b>EXPERIMENTAL AND NONEXPERIMENTAL RESEARCH METHODS IN EDUCATION II</b><br>3 cr. (3 and 0)<br>Advanced concepts and skills necessary to analyze, conduct and evaluate educational research; nonexperimental, quasi-experimental and experimental design specific to problems in educational research; complementary educational research methods involving qualitative approaches; coding and computer analysis of sample data; summarization and interpretation of data; applications of measurement and evaluation in educational research. <b>Prerequisite:</b> EDF 778, 808 and EX ST 801, or equivalent. |
| <b>EDF 879</b> | <b>QUALITATIVE RESEARCH IN EDUCATION</b><br>3 cr. (3 and 0)<br>Application of qualitative studies to educational questions; examination of the nature of qualitative research; examination of rationale  |



and applications of qualitative research methods; particular attention is given to integration of qualitative and quantitative research methods in educational research. **Prerequisite:** EDF 778, 878 or equivalent.

- EDSP 602 THE EXCEPTIONAL CHILD**  
3 cr. (3 and 0)
- EDSP 614 (PRTM 614) RECREATION AND LEISURE FOR SPECIAL POPULATIONS**  
3 cr. (3 and 0)
- EDSP 669 CHARACTERISTICS OF CHILDREN WITH EMOTIONAL HANDICAPS**  
3 cr. (3 and 0)
- EDSP 670 CHARACTERISTICS OF CHILDREN WITH LEARNING DISABILITIES**  
3 cr. (3 and 0)
- EDSP 672 PSYCHOLOGY OF MENTAL RETARDATION**  
3 cr. (3 and 0)
- EDSP 673 TEACHING THE MENTALLY RETARDED**  
3 cr. (3 and 0)
- EDSP 674 EDUCATIONAL PROCEDURES FOR CHILDREN WITH EMOTIONAL HANDICAPS**  
3 cr. (3 and 0)
- EDSP 675 EDUCATIONAL PROCEDURES FOR CHILDREN WITH LEARNING DISABILITIES**  
3 cr. (3 and 0)
- EDSP 676 PRACTICUM IN LEARNING DISABILITIES**  
3 cr. (2 and 3)
- EDSP 677 CHARACTERISTICS OF CHILDREN WHO ARE GIFTED**  
3 cr. (3 and 0)
- EDSP 678 PRACTICUM IN EMOTIONALLY HANDICAPPED**  
3 cr. (2 and 3)
- EDSP 679 PRACTICUM IN MENTALLY RETARDED**  
3 cr. (2 and 3)
- EDSP 820 TEACHING LANGUAGE ARTS TO THE EXCEPTIONAL CHILD**  
3 cr. (3 and 0)  
Various approaches to teaching listening, writing, reading and speaking skills to the exceptional child.
- EDSP 821 ASSESSMENT OF THE EXCEPTIONAL CHILD**  
3 cr. (3 and 0)  
Interpreting psychological reports, writing educational prescriptions, administering selected tests and designing informal tests. **Prerequisites:** ED 471/671 and sequence of ED 472/672 or ED 469/669 and 474/674 and 476/676; or ED 470/670 and 475/675.

- EDSP 822 TEACHING MATHEMATICS TO THE EXCEPTIONAL CHILD**  
3 cr. (3 and 0)  
Various approaches to teaching mathematics to the exceptional child.
- EDSP 823 MAINSTREAMING THE HANDICAPPED**  
3 cr. (3 and 0)  
Needs of the handicapped and instructional strategies for accommodating exceptional children in the mainstream. For regular classroom teachers and administrators. **Prerequisite:** Permission of instructor.
- EDSP 824 SECONDARY CURRICULUM ADAPTATIONS FOR THE HANDICAPPED**  
3 cr. (3 and 0)  
Designed for teachers of handicapped students in secondary schools; adaptation of curriculum and instruction to meet the needs of students with mild to moderate learning handicaps. Topics include text modification, study skills, curriculum design and mainstreaming. **Prerequisite:** ED 471/671 or permission of instructor.
- EDSP 825 CAREER/VOCATIONAL EDUCATION FOR THE HANDICAPPED**  
3 cr. (3 and 0)  
Designed for special education teachers at the secondary level to attain the necessary competency to assist the handicapped adolescent in preparing for the world of work. **Prerequisite:** ED 471/671 or permission of instructor.
- EDSP 853 ADMINISTRATION AND SUPERVISION OF SPECIAL EDUCATION**  
3 cr. (3 and 0)  
Administrative and supervisory practices in initiating, maintaining and expanding special education programs; especially for principals, supervisors and directors of instruction. **Prerequisite:** ED 471/671 or permission of instructor.
- EDSP 881 INDIVIDUAL TESTING**  
3 cr. (3 and 0)  
Interpretation of Wechsler scales with supervised practice in their administration. **Prerequisites:** ED 701, 702, 809, EDF 808 and permission of instructor.
- EDSP 884 SCHOOL PSYCHOLOGY**  
3 cr. (3 and 0)  
Roles and function of the school psychologist, legal/ethical issues; planning and evaluating school psychology service delivery systems; specialized practice procedures to evaluate learning and behavior problems. **Prerequisites:** ED 701 or 702, and ED 809 or EDF 808, and permission of instructor.
- EDSP 930 ADVANCED STUDIES IN FOUNDATIONS OF SPECIAL EDUCATION**  
3 cr. (3 and 0)  
Historical, psychological and sociological foundations of special education, emphasizing current federal legislation; federal, state, case law and pending litigation impacting special education programming. **Prerequisites:** Graduate standing, EDL 725 and ED 853 or permission of instructor.



- EDSP 931**      **ADVANCED METHODS AND CURRICULUM DEVELOPMENT IN LEARNING DISABILITIES**  
3 cr. (3 and 0)  
Theory, research and practice pertaining to selected issues in methods and curriculum in the field of learning disabilities, emphasizing the preparation, selection and adaptation of instructional materials for learning-disabled students. **Prerequisites:** Graduate standing, EDF 778 and ED 821 or permission of instructor.
- EDSP 932**      **ADVANCED METHODS AND CURRICULUM DEVELOPMENT IN EMOTIONALLY HANDICAPPED**  
3 cr. (3 and 0)  
History, research and practice pertaining to effective methods of working with the emotionally handicapped, emphasizing the impact of various theoretical models on curriculum development and intervention. **Prerequisites:** Graduate standing and ED 821.
- EDSP 933**      **ADVANCED METHODS AND CURRICULUM DEVELOPMENT IN MENTALLY HANDICAPPED**  
3 cr. (3 and 0)  
History, theory, research and practice pertaining to the education of the mentally handicapped, emphasizing the development and implementation of community-based as well as lifespan curricula development. **Prerequisites:** Graduate standing and ED 821.
- EDSP 934**      **PROGRAM MODELS, EVALUATION AND CURRENT TRENDS IN SPECIAL EDUCATION**  
3 cr. (3 and 0)  
Program models, program evaluation and current trends and issues in programming which impact the future growth of special education. **Prerequisites:** Graduate standing and ED 930.

### **Parks, Recreation and Tourism Management**

Ann E. James, Chair, Department of Parks, Recreation and Tourism Management

**Major**  
Parks, Recreation and  
Tourism Management

**Degrees**  
M.P.R.T.M., M.S., Ph.D.

The department offers a professional master's degree (M.P.R.T.M.), a Master of Science degree (M.S.) and a Doctor of Philosophy degree (Ph.D.). Flexibility permits individual development in professional interest areas such as therapeutic recreation, travel and tourism management, recreation resource management and interpretation, and administration of recreation, park or tourism systems. Each student's program is tailored to suit his or her personal and professional goals. Applicants from nonrecreation disciplines are required to develop background knowledge of recreation through undergraduate course work. All applicants must submit GRE scores.

The Master of Parks, Recreation and Tourism Management should be selected by individuals who intend to enter or reenter the workplace upon the completion of degree requirements. Applicants for the M.P.R.T.M. degree who document at least three years of relevant professional experience beyond a bachelor's degree in recreation and a 3.0 undergraduate GPR are not required to submit GRE scores for admission. Each candidate completes

an independent project to meet degree requirements. A minimum of 36 hours of course work is required.

The Master of Science is a research degree with a research thesis requirement. This degree is designed for individuals planning to undertake doctoral study or seek employment in a research-related position. Candidates must complete a minimum of 30 hours of course work and six hours of research culminating in a thesis.

The Doctor of Philosophy is an advanced research degree requiring performance of original research leading to a dissertation. Comprehensive and final examinations and 18 hours of dissertation research are required. Course work is determined by each student's doctoral committee.

- PRTM 600**      **SUPERVISION OF RECREATION PERSONNEL PATTERNS AND PROCESSES**  
3 cr. (3 and 0)
- PRTM 611**      **THERAPEUTIC RECREATION FOR SELECTED POPULATIONS**  
3 cr. (2 and 3)
- PRTM 612**      **THERAPEUTIC RECREATION AND MENTAL HEALTH**  
3 cr. (3 and 0)
- PRTM 613**      **THERAPEUTIC RECREATION FOR PHYSICALLY DISABLED**  
3 cr. (2 and 3)
- PRTM 614**      **RECREATION AND LEISURE FOR SPECIAL POPULATIONS**  
(EDSP 614)  
3 cr. (3 and 0)
- PRTM 615**      **METHODS IN REDUCING RISKS FOR MIDDLE CHILDHOOD**  
(EDF 615)  
3 cr. (2 and 3)
- PRTM 621**      **RECREATION FINANCIAL RESOURCE MANAGEMENT**  
3 cr. (3 and 0)
- PRTM 630**      **WORLD GEOGRAPHY OF RECREATION AND PARKS**  
3 cr. (3 and 0)
- PRTM 631**      **METHODS OF ENVIRONMENTAL INTERPRETATION**  
3 cr. (2 and 3)
- PRTM 641**      **COMMERCIAL RECREATION**  
3 cr. (3 and 0)
- PRTM 643**      **RESORTS IN NATIONAL AND INTERNATIONAL TOURISM**  
3 cr. (3 and 0)
- PRTM 644**      **TOUR PLANNING AND OPERATIONS**  
3 cr. (3 and 0)
- PRTM 645**      **CONFERENCE/CONVENTION PLANNING AND MANAGEMENT**  
3 cr. (3 and 0)
- PRTM 646**      **COMMUNITY TOURISM DEVELOPMENT**  
3 cr. (3 and 0)
- PRTM 647**      **PERSPECTIVES ON INTERNATIONAL TRAVEL**  
3 cr. (3 and 0)



<b>PRTM 648</b>	<b>MICRO-ORGANIZATION OF THE TOURISM INDUSTRY</b> 3 cr. (3 and 0)	<b>PRTM 801</b>	<b>PHILOSOPHICAL FOUNDATIONS OF RECREATION AND PARK ADMINISTRATION</b> 3 cr. (3 and 0) Current theories and philosophies in recreation as they are influenced by and have influence on leisure and the changing environment in America; student develops his or her own professional philosophy of recreation and leisure.
<b>PRTM 652</b>	<b>CAMPUS RECREATION</b> 3 cr. (3 and 0)	<b>PRTM 802</b>	<b>GROUP PROCESSES IN LEISURE SERVICES</b> 3 cr. (3 and 0) Improvement in human relations skills; knowledge of interpersonal needs and problems of individuals and groups; students gain understanding of how others affect them and how they affect others and become more effective professional recreators, park administrators, supervisors, interpreters and educators.
<b>PRTM 672</b>	<b>HISTORIC SITE INTERPRETATION</b> 3 cr. (3 and 0)	<b>PRTM 803</b>	<b>SEMINAR IN RECREATION AND PARK ADMINISTRATION</b> 3 cr. (3 and 0) Case problems relating to administration of a park, recreation or tourism agency.
<b>PRTM 673</b>	<b>INTRODUCTION TO MUSEOLOGY</b> 3 cr. (2 and 3)	<b>PRTM 804</b>	<b>COMPREHENSIVE RECREATION PLANNING</b> 3 cr. (3 and 0) Comprehensive recreation planning theories and practices at federal, state and local levels; selected case study projects are undertaken in cooperation with other university departments and government agencies.
<b>PRTM 701</b>	<b>FOUNDATIONS OF PARKS, RECREATION AND TOURISM MANAGEMENT</b> 2 cr. (2 and 0) Basic concepts and principles in the parks, recreation and tourism management field. Does not count toward degree requirements for PRTM students. <b>Prerequisite:</b> Graduate standing.	<b>PRTM 805</b>	<b>RECREATIONAL ASPECTS OF WATER RESOURCES</b> 3 cr. (3 and 0) Relationship of recreation to water; history and legislative background; governmental involvement; current research related to planning, pollution and demand; future policy decisions.
<b>PRTM 705</b>	<b>INTERNSHIP</b> 1-3 cr. (0 and 9+) Field placement in an approved agency under qualified supervision. Graded on a pass/fail basis. <b>Prerequisite:</b> PRTM student or permission of instructor.	<b>PRTM 806</b>	<b>URBAN RECREATION ANALYSIS</b> 3 cr. (3 and 0) Interrelationship of social, political and economic factors in providing public or private recreation services in urban areas.
<b>PRTM 706</b>	<b>COMPUTER-ASSISTED ADMINISTRATION IN LEISURE SERVICES</b> 3 cr. (2 and 3) Decision-making and administrative techniques featuring the use of the microcomputer and related software to resolve administrative problems in the field of leisure services.	<b>PRTM 807</b>	<b>RECREATION BEHAVIOR IN NATURAL ENVIRONMENTS</b> 3 cr. (3 and 0) The social, psychological and environmental influences on human behavior; identification of theoretical perspectives to explain behavior and to resolve problems in recreation resource management. <b>Prerequisite:</b> Graduate standing.
<b>PRTM 707</b>	<b>PRINCIPLES OF ENVIRONMENTAL INTERPRETATION</b> 3 cr. (3 and 0) Methods of providing learning experiences in the out-of-doors, focusing on meaning, scope and values of interpretation.	<b>PRTM 808</b>	<b>BEHAVIORAL ASPECTS OF PARKS, RECREATION AND TOURISM MANAGEMENT</b> 3 cr. (3 and 0) Behavioral aspects of recreation, focusing on the social and psychological dimensions of the recreation experience in a variety of environments and activities. <b>Prerequisite:</b> Graduate standing.
<b>PRTM 708</b>	<b>INDEPENDENT STUDY</b> 1-3 cr. (1-3 and 0) Topics in recreation, leisure and tourism; students study an area not covered in other courses; a written report of findings is required. May be repeated for a maximum of three credits. <b>Prerequisite:</b> Permission of the supervising faculty before registration.		
<b>PRTM 709</b>	<b>SPECIAL PROBLEMS</b> 1-3 cr. (1-3 and 0) Directed, individual comprehensive investigation of a special problem to use knowledge gained in formal courses, provide experience and training in research, and prepare for professional goals; report of findings required. May be repeated with a maximum of three credit hours applied toward graduation requirements. Graded on a pass/fail basis.		
<b>PRTM 710</b>	<b>CURRENT ISSUES IN RECREATION</b> 1 cr. (1 and 0) Seminar in current topics, emphasizing student preparation, organization and communication of material and ideas not covered in formal courses. May be repeated for a maximum of three semester hours of credit.		



- PRTM 811 RESEARCH METHODS IN PARKS, RECREATION AND TOURISM MANAGEMENT**  
3 cr. (3 and 0)  
Principles, methods and strategies for planning, designing, evaluating and applying studies of recreation. **Prerequisite:** A graduate-level statistics course or permission of instructor.
- PRTM 812 LEISURE SERVICES FOR THE ELDERLY**  
3 cr. (3 and 0)  
The elderly and the role of leisure services in later life; needs of community-based and institutionalized elderly; service delivery systems to meet these needs.
- PRTM 815 THERAPEUTIC RECREATION AND ACTIVITY THERAPY ADMINISTRATION**  
3 cr. (3 and 0)  
Service delivery structures; interdisciplinary relationships; consultation methods; in-service training; funding sources; service evaluation in therapeutic recreation and activity therapy programs.
- PRTM 816 REMOTE SENSING AND GIS IN NATURAL RESOURCES**  
(FOR 816)  
3 cr. (2 and 3) S (odd numbered years)  
See FOR 816 for description.
- PRTM 820 RECREATION RESOURCE POLICY ISSUES AND PROCESSES**  
3 cr. (3 and 0)  
Outdoor recreation policy-formation structures and processes are surveyed through case studies involving past and current public policy issues.
- PRTM 840 TOURISM PLANNING**  
3 cr. (3 and 0)  
Tourism planning procedures and techniques. Topics include the planning process and associated concerns such as market, facility, infrastructure, environment, culture and economics. **Prerequisite:** Graduate standing.
- PRTM 841 SEMINAR IN EXPOSITION MANAGEMENT**  
3 cr. (3 and 0)  
Students gain an understanding of the theory, concepts and practices necessary to assume positions with world fairs, agricultural fairs and arenas, trade shows, national and world trade centers, or consumer and industrial exhibitions.
- PRTM 843 TOURISM ANALYSIS**  
3 cr. (3 and 0)  
Selected theories, methods, techniques, practices and principles which govern tourism behavior. **Prerequisite:** Graduate standing or one graduate level statistics course or permission of instructor.
- PRTM 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.
- PRTM 900 SELECTED TOPICS**  
1-3 cr. (1-3 and 0)  
In-depth, timely study of trends or problems in parks, recreation and tourism not covered

in other courses. May be repeated for a maximum of six credits.

- PRTM 908 ADVANCED TOPICS**  
1-3 cr. (1-3 and 0)  
Advanced study of topics not covered in other PRTM courses and not directly related to a thesis or dissertation topic; a formal paper is required. May be taken for a maximum of three credits per semester. May be repeated for a maximum of six credits. **Prerequisite:** Permission of instructor.
- PRTM 910 RESEARCH SEMINAR**  
1 cr. (1 and 0)  
Current research developments in PRTM and presentation of research projects. May be taken for credit for two semesters. Graded on a pass/fail basis.
- PRTM 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged

### Public Health

Debra B. Jackson, Chair, Department of Public Health

Major	Degree
Health Administration	M.H.A.

Clemson University and the Medical University of South Carolina jointly offer the Master of Health Administration degree. The M.H.A. program consists of 50 semester hours of course work: 21 hours of health administration, 21 hours of business and eight hours of graduate electives. Depending on a student's background, a three-credit internship may be required. All classes are taught at the University Center of Greenville by faculty from the Medical University of South Carolina and Clemson University.

*These courses are the core courses in the program. The MBA and MGT course descriptions are under the respective departmental headings.*

- MHA 719 HEALTH CARE MANAGEMENT**  
3 cr. (3 and 0)  
Structure and function of the well-managed and appropriately led acute care hospital; other health service organizations and general management and operations theory also considered.
- MHA 721 HEALTH CARE DELIVERY SYSTEMS**  
3 cr. (3 and 0)  
Overview of the development of the health services delivery system in the United States.
- MHA 722 HEALTH BEHAVIOR AND EPIDEMIOLOGY**  
2 cr. (2 and 0)  
Understanding the health behavior of a population and individuals; concept of the health status of a population, methods of measurement and sources of data.
- MHA 729 HEALTH CARE FINANCE**  
3 cr. (3 and 0)  
Selected financial management topics including working capital management, capital budgeting, debt and equity instruments, and financial statement analysis.



- MHA 734 HEALTH CARE ECONOMICS AND POLICY**  
3 cr. (3 and 0)  
Economic and policy concepts and analyses as applied to health care.
- MHA 735 HEALTH LAW AND RISK MANAGEMENT**  
2 cr. (2 and 0)  
Legal concepts and issues related to health care management.
- MHA 752 HEALTH ADMINISTRATION FIELD PROJECT**  
3 cr. (3 and 0)  
Application of principles, theories and concepts to a well-defined problem or issue currently confronting the health service administrator.
- MHA 853 SEMINAR IN HEALTH ADMINISTRATION AND LEADERSHIP**  
2 cr. (2 and 0)  
Integration of knowledge and skills acquired across all courses in the context of strategic management.
- MBA 803 STATISTICAL ANALYSIS OF BUSINESS OPERATIONS**  
3 cr. (3 and 0)
- MBA 804 MANAGERIAL ACCOUNTING AND INFORMATION SYSTEMS**  
3 cr. (3 and 0)
- MBA 806 OPERATIONS MANAGEMENT**  
3 cr. (3 and 0)
- MBA 808 MANAGERIAL PROBLEMS IN MARKETING**  
3 cr. (3 and 0)
- MBA 810 MANAGERIAL POLICY**  
3 cr. (3 and 0)
- MGT 809 ORGANIZATION THEORY AND BEHAVIOR**  
(M B A 809) 3 cr. (3 and 0)
- MGT 815 PERSONNEL MANAGEMENT**  
3 cr. (3 and 0)

*These courses offered by MUSC and by Clemson University are elective courses. The HRD, MGT, HLTH, MBA and ACCT course descriptions are under the respective departmental headings.*

- MHA 601 HEALTH CARE ETHICS**  
3 cr. (3 and 0)  
Examination and analysis of the professional standards, laws, political and economic forces that establish a context for health care ethics.
- MHA 632 PROGRAM EVALUATION IN HEALTH SERVICES**  
3 cr. (3 and 0)  
General application of evaluative research in a variety of health care settings, administrative purposes of evaluation of organizational components and/or programs, and the design and implementation of evaluative efforts.
- MHA 638 SELECTED TOPICS IN HEALTH ADMINISTRATION**  
1 cr. (1 and 0)  
Topics vary to reflect current state-of-art issues and topics in health administration.

Graded on a pass/fail basis. May be repeated for a total of six credit hours as topics vary.

- MHA 640 MANAGING WITH HEALTH PROFESSIONALS**  
3 cr. (3 and 0)  
Learning about clinical professionals and exploring ways to facilitate effective and efficient team relationships in the management and delivery of health services.
- MHA 741 SEMINAR IN COMMUNITY AND RURAL HEALTH**  
3 cr. (3 and 0)  
Introduction to community health planning concepts and methods and the unique aspects of rural health among the population residing there.
- ACCT 830 GOVERNMENTAL AND NOT-FOR-PROFIT ACCOUNTING**  
3 cr. (3 and 0)
- HLTH 620 HEALTH PROMOTION AND WELLNESS INTERNSHIP**  
1-6 cr. (0 and 3-18)
- H R D 830 CONCEPTS OF HUMAN RESOURCE DEVELOPMENT**  
3 cr. (3 and 0)
- MGT 818 MANAGEMENT SUPPORT SYSTEMS**  
3 cr. (3 and 0)
- M B A 802 MANAGERIAL ECONOMICS**  
3 cr. (3 and 0)
- M B A 813 INDUSTRIAL RELATIONS**  
3 cr. (3 and 0) N
- M B A 828 SERVICES MARKETING**  
3 cr. (3 and 0) N

### Technology and Human Resource Development

Gerald G. Lovedahl, Chair, Department of Technology and Human Resource Development

Majors	Degrees
Human Resource Development	M.H.R.D.
Industrial Education	M.In.Ed.
Vocational/Technical Education	Ed.D.

The human resource field is a specialized blend of education, counseling, psychology, management and sociology. The human resource development (HRD) program is designed to prepare industrial training directors, educational specialists, training coordinators and personnel for HRD occupations in industry.

HRD specialists commonly provide training related to the areas of technical and interpersonal skills, management and motivation. The HRD program is designed to involve and enhance a variety of professional management activities. The program serves professionals working in the areas of manufacturing, construction, health occupations, secretarial sciences, graphic communications, transportation, loss control, quality assurance and personnel management.

Graduates of the program are capable of utilizing contemporary instructional technologies and methodologies. Program participants gain valuable skills and knowledge related to the varied roles of the training specialist.



Applicants to the HRD program are reviewed on undergraduate course work, academic performance and employment experience. The HRD program requires 36 hours, including 15 hours in core human resource development courses, six hours in research methods and 15 hours in course work appropriate to individual career objectives.

<b>THRD 610</b> (G C 610)	<b>SELECTED TOPICS</b> 1-3 cr. (1-3 and 0)
<b>THRD 613</b>	<b>CONTEMPORARY TECHNOLOGICAL PROBLEMS</b> 3 cr. (3 and 0)
<b>THRD 615</b>	<b>HISTORY AND PHILOSOPHY OF INDUSTRIAL AND VOCATIONAL EDUCATION</b> 3 cr. (3 and 0)
<b>THRD 620</b>	<b>MANUFACTURING TECHNOLOGY II: MATERIALS AND PROCESSES</b> 3 cr. (2 and 3)
<b>THRD 630</b>	<b>CONSTRUCTION TECHNOLOGY II: PRACTICES AND SYSTEMS</b> 3 cr. (2 and 3)
<b>THRD 640</b>	<b>POWER TECHNOLOGY II: TRANSMISSION AND CONTROL SYSTEMS</b> 3 cr. (2 and 2)
<b>THRD 641</b>	<b>INTERNAL COMBUSTION ENGINES</b> 3 cr. (2 and 3)
<b>THRD 650</b>	<b>ELECTRONICS FOR EDUCATORS</b> 3 cr. (1 and 6)
<b>THRD 660</b>	<b>DEVELOPING TRAINING PROGRAMS FOR INDUSTRY</b> 3 cr. (3 and 0)
<b>THRD 665</b>	<b>CONDUCTING AND EVALUATING TRAINING PROGRAMS FOR INDUSTRY</b> 3 cr. (3 and 0)
<b>THRD 668</b>	<b>PUBLIC RELATIONS</b> 3 cr. (3 and 0)
<b>THRD 670</b>	<b>COURSE ORGANIZATION AND EVALUATION</b> 3 cr. (3 and 0)
<b>THRD 671</b>	<b>TEACHING INDUSTRIAL SUBJECTS</b> 3 cr. (3 and 0)
<b>THRD 673</b>	<b>COMPETENCY TESTING IN VOCATIONAL SUBJECTS</b> 3 cr. (3 and 0)
<b>THRD 674</b>	<b>SCHOOL SAFETY</b> 3 cr. (3 and 0)
<b>THRD 680</b> (EDF 680) (AG ED 680)	<b>EDUCATIONAL APPLICATIONS OF MICROCOMPUTERS</b> 3 cr. (2 and 2)
<b>THRD 682</b> (EDF 682) (AG ED 682)	<b>ADVANCED EDUCATIONAL APPLICATIONS OF MICROCOMPUTERS</b> 3 cr. (2 and 2)

<b>THRD 683</b>	<b>ARCHITECTURAL DRAFTING FOR INDUSTRIAL EDUCATION</b> 3 cr. (1 and 6)
<b>THRD 684</b>	<b>COMMUNICATIONS TECHNOLOGY II: SYSTEMS</b> 3 cr. (2 and 2)
<b>THRD 686</b>	<b>INSTRUCTIONAL VIDEO PRODUCTION</b> 3 cr. (1 and 4)
<b>THRD 692</b>	<b>ADVANCED PROJECTS</b> 1-6 cr.
<b>H R D 830</b>	<b>CONCEPTS OF HUMAN RESOURCE DEVELOPMENT</b> 3 cr. (3 and 0) Theory and practice of contemporary applications of human resource development (HRD) programs; training and development functions; strategies for designing and developing programs; and application of methods, techniques and resources in the context of changing needs, technologies, demographics and economic circumstances that create the need for different skills and knowledge in the work force. <b>Prerequisite:</b> Permission of instructor.
<b>H R D 845</b> (IN ED 845)	<b>NEEDS ASSESSMENT FOR EDUCATION AND INDUSTRY</b> 3 cr. (3 and 0) Theory and practice of needs assessment activities in human resource development (HRD) programs; importance of the process to the identification of content/curricula topics and the overall training environment; specific methodologies used in the needs assessment process; supportive components of various program planning systems. <b>Prerequisite:</b> H R D 830 or permission of instructor.
<b>H R D 846</b> (IN ED 846)	<b>APPLIED PUBLIC RELATIONS</b> 3 cr. (3 and 0) Practical and theoretical approaches to problem identification and the development of respective solutions in the public relations process; action and message generation, media development and evaluation of public relations techniques in existing organizations. <b>Prerequisites:</b> Employment or ready access to an employer and place of employment; THRD 468/668 is desirable.
<b>H R D 847</b> (IN ED 847)	<b>INSTRUCTIONAL SYSTEMS DESIGN</b> 3 cr. (3 and 0) Theory and practice of instructional systems development activities in human resource development (HRD) programs; identification, selection and organization of subject matter appropriate for competency-based training (CBT) programs; occupational analysis techniques; rationale statements, goals and objectives; related instructional materials; participant evaluation; and instructional scheduling. <b>Prerequisites:</b> H R D 830 and 845 or permission of instructor.



**H R D 849** **EVALUATION OF TRAINING AND DEVELOPMENT/HRD PROGRAMS**  
3 cr. (3 and 0)  
Theory and practice of evaluation processes related to training and development in human resource development (HRD) programs; developing a results-oriented approach based on specific criteria or standards; designing instruments; determining program costs; and collecting, analyzing and interpreting data to ascertain return on investment. **Prerequisites:** H R D 830, 845, 847, 860 and IN ED 889 or permission of instructor.

**H R D 860** **INSTRUCTIONAL MATERIALS DEVELOPMENT**  
(IN ED 860) 3 cr. (3 and 0)  
Development and application of instructional materials and laboratory activities for training programs in education and industry; reinforcement of instructional training concepts and materials development procedures that are applied across human resource development (HRD) programs. **Prerequisites:** H R D 830 and 845.

**H R D 870** **CONSULTING FOR EDUCATION AND INDUSTRY**  
(IN ED 870) 3 cr. (3 and 0)  
Theory and practice of external and internal consulting practices in human resource development (HRD) programs; dynamics of a professional helping relationship; methods and techniques for initiating and terminating consulting relationships; diagnosing client situations; identification, selection and implementation of alternative problem solutions; evaluation of professional consulting relationships. **Prerequisite:** H R D 830 or permission of instructor.

**H R D 897** **APPLIED RESEARCH AND DEVELOPMENT**  
3 cr. (3 and 0)  
Study of a particular topic under the direction of a faculty member; students identify a special problem related to the human resource development (HRD) profession based on their personal interests, experiences, needs and goals. **Prerequisites:** Submission of a written proposal, prior approval of advisor and satisfactory completion of 12 hours of graduate HRD courses and IN ED 889.

### Industrial Education

The Master of Industrial Education degree allows for specialization in four areas: industrial technology education, vocational/technical education, administration and supervision for the two-year college, and graphic communications.

Sufficient flexibility is permitted to structure each student's plan of study to meet the objectives for any of the areas of specialization listed above. The industrial technology area is designed to enhance competencies in teaching industrial technology and prevocational and career education. Those who want to improve their competency in teaching and administering vocational or technical subjects in secondary or postsecondary institutions specialize in the vocational/technical area. The program in administration and supervision for the two-year college is designed specifically for persons preparing for administrative or supervisory positions in the technical colleges. Graphic communications specialists pursue technical and professional study to enter careers in

printing management, sales and technical teaching in postsecondary graphic communications programs.

In addition to the general requirements for admission to the Graduate School, departmental requirements for admission to each of the areas of specialization are as follows:

1. Industrial technology education applicants must hold or meet the minimum requirements for an industrial arts or technology teacher's certificate.
2. Vocational/technical education applicants must hold or meet the minimum requirements for a trade and industrial teacher's certificate, or show vocational or technical competence through training, work experience or proficiency test results.
3. The program in administration and supervision for the two-year college requires the applicant to show evidence of competency in a teaching area or to have a minimum of 24 semester hours of courses appropriate to the vocational or technical program to be administered or supervised.
4. Graphic communications specialists must have a technical background in one or more phases of graphic communications or complete a specified sequence of prerequisite courses.

Candidates for the Master of Industrial Education degree are required to complete the following:

1. 18 hours in subjects that contribute to the student's technical, administrative and/or supervisory competence;
2. six hours in research and special problems; and
3. six to 12 hours taken outside the major department.

**IN ED 665** **INSTRUCTIONAL VIDEO PRODUCTION**  
3 cr. (1 and 4)

**IN ED 700** **SUPERVISING THE STUDENT TEACHER IN THE PUBLIC SCHOOL**  
(ED 700) 2-3 cr. (2-3 and 0)  
See ED 700 for description.

**IN ED 815** **SEMINAR IN INDUSTRIAL EDUCATION**  
1 cr. (1 and 0)  
Students and faculty discuss and study new technological and professional advances. May be taken up to three times. Graded on a pass/fail basis.

**IN ED 820** **RECENT PROCESS DEVELOPMENTS**  
3 cr. (3 and 0)  
Recent technological innovations, inventions, processes and products, and their impact on our industrial, labor, educational and social institutions.

**IN ED 840** **SCHOOL SHOP DESIGN**  
3 cr. (3 and 0)  
All aspects of unit shops, general shops and comprehensive shops for schools offering vocational industrial subjects and industrial arts courses.

**IN ED 845** **NEEDS ASSESSMENT FOR EDUCATION AND INDUSTRY**  
(H R D 845) 3 cr. (3 and 0)  
See H R D 845 for description.

**IN ED 846** **APPLIED PUBLIC RELATIONS**  
(H R D 846) 3 cr. (3 and 0)  
See H R D 846 for description.



**IN ED 847 INSTRUCTIONAL SYSTEMS DESIGN****(H R D 847)**

3 cr. (3 and 0)

See H R D 847 for description.

**IN ED 850****ISSUES IN INDUSTRIAL TECHNOLOGY**

1-3 cr. (1-3 and 0)

Industrial technology for public school teachers and individuals employed in business and industry; emphasis is on emerging technologies and innovations in instructional strategies. **Prerequisite:** Graduate status.

**IN ED 851****CURRENT TOPICS IN COMMUNICATION TECHNOLOGY**

1-3 cr. (1-3 and 0)

Recent technological processes in the communication industry, such as CAD, desktop publishing and interactive video, for teachers and industrial personnel. **Prerequisite:** Graduate status.

**IN ED 852****CURRENT TOPICS IN MANUFACTURING TECHNOLOGY**

1-3 cr. (1-3 and 0)

Contemporary manufacturing practices for public school teachers and industry personnel.

**IN ED 853****CURRENT TOPICS IN CONSTRUCTION TECHNOLOGY**

1-3 cr. (1-3 and 0)

Update for teachers in industrial technology education programs at the secondary level, instructors in construction-related programs at the postsecondary level and industrial trainers in the private sector; emphasis is on contemporary technological processes in construction industries.

**IN ED 854****CURRENT TOPICS IN POWER TECHNOLOGY**

1-3 cr. (1-3 and 0)

Contemporary applications of power and energy for public school teachers and industry personnel.

**IN ED 860  
(H R D 860)****INSTRUCTIONAL MATERIALS DEVELOPMENT**

3 cr. (3 and 0)

See H R D 860 for description.

**IN ED 865****AMERICAN INDUSTRIES**

3 cr. (3 and 0)

Concepts and principles of American industry and technology; industrial plant visits supplement study of industrial organization, economics, management, production and products.

**IN ED 870  
(H R D 870)****CONSULTING FOR EDUCATION AND INDUSTRY**

3 cr. (3 and 0)

See H R D 870 for description.

**IN ED 889****RESEARCH IN EDUCATION****(ED 889)  
(AG ED 889)**

3 cr. (3 and 0)

See AG ED 889 for description.

**IN ED 894****PROJECT RESEARCH**

1-6 cr. (1-6 and 0)

Research related to departmental projects. Open only to students planning to pursue ad-

vanced graduate study. Joint use with IN ED 895, 896 not permitted for degree.

**IN ED 895  
(G C 895)****SPECIAL PROBLEMS I**

3 cr. (3 and 0)

Special problems in industrial education, varying with interests, experiences and needs of students. **Prerequisites:** Submission of a written proposal, prior approval of advisor and completion of nine hours in the major.

**IN ED 896  
(G C 896)****SPECIAL PROBLEMS II**

3 cr. (3 and 0)

Continuation of IN ED 895. **Prerequisites:** Submission of a written proposal, prior approval of advisor and completion of IN ED 895.

**Vocational/Technical Education**

The Doctor of Education degree in vocational and technical education prepares graduates for leadership positions in the profession. Curricula are designed for vocationally and technically oriented personnel in colleges, universities, public schools, industry and vocationally related agencies.

Areas of specialization are available in the following fields:

1. Administration — technical colleges and public schools.
2. Curriculum and Instruction — technical colleges, industry and public schools. Emphasis is on curriculum development, materials and instructional technologies, and human resource development.
3. Guidance — technical colleges, public schools and vocational agencies.
4. Teaching — technical colleges and public schools.

An applicant for the Ed.D. degree must hold bachelor's and master's degrees from approved colleges and must have completed a minimum of three years of successful experience appropriate to his or her proposed field of professional service. (This requirement may be waived for admission, but the applicant cannot become a candidate for the degree until the requirement is met.)

The Ed.D. program consists of graduate course work in vocational and technical foundations, statistics and research, advanced study and an internship in an appropriate field of professional service, and a dissertation.

**VT ED 810****FOUNDATIONS OF VOCATIONAL AND TECHNICAL EDUCATION**

3 cr. (3 and 0)

Evolution of vocational and technical education during the twentieth century and current trends; sociological, psychological and philosophical theories underlying current objectives; definition of broad parameters of the field.

**VT ED 812****VOCATIONAL AND TECHNICAL PROGRAM FINANCE**

3 cr. (3 and 0)

National, state and local legislation governing financial support of vocational/technical programs; development of budget, audit, and financial administrative plans and systems. **Prerequisites:** VT ED 810 and EDL 745 or equivalent.



- VT ED 833 CURRICULUM CONSTRUCTION IN VOCATIONAL AND TECHNICAL EDUCATION**  
3 cr. (3 and 0)  
Students develop a specific course in a selected vocational and technical education area by specifying performance goals and building around these objectives. **Prerequisite:** AG ED 640 or THRD 670 or equivalent.
- VT ED 850 PROGRAMS, CONCEPTS AND ISSUES IN VOCATIONAL AND TECHNICAL EDUCATION**  
3 cr. (3 and 0)  
Current activities and debates in vocational and technical education; traditional and innovative programs, career education, school finance, disadvantaged students, handicapped youth, sex equality and other specialized programs.
- VT ED 861 ADMINISTRATION AND SUPERVISION IN VOCATIONAL AND TECHNICAL EDUCATION**  
3 cr. (3 and 0)  
Principles and practices for administering and supervising vocational and technical schools and classes under federal vocational acts, state regulations and local policies. **Prerequisite:** VT ED 810 or permission of instructor.
- VT ED 876 COLLEGE TEACHING**  
3 cr. (3 and 0)  
Instructional practices; curriculum; techniques of organizing and planning learning experiences; analysis of teaching strategies and systems.
- VT ED 882 SEMINAR**  
1 cr. (1 and 0)  
Current issues and problems and proposed research projects.
- VT ED 893 ADVANCED RESEARCH DESIGN AND ANALYSIS**  
3 cr. (3 and 0)  
Emphasis on the dissertation from the proposal to the fully developed outline of all chapters. Required of all doctoral candidates in the vocational/technical education program. **Prerequisite:** AG ED 889 or equivalent.
- VT ED 955 (EDL 955) THE TWO-YEAR COLLEGE**  
3 cr. (3 and 0)  
See EDL 955 for description.
- VT ED 980 INTERNSHIP IN VOCATIONAL/TECHNICAL EDUCATION**  
1-6 cr. (0 and 3-18)  
Internship in which the student gains experience working in a chosen area of specialization in vocational/technical education; field experience activities must be planned to build competence in the student's field of specialization. Graded on a pass/fail basis. **Prerequisite:** Permission of the student's major advisor.
- VT ED 991 DOCTORAL DISSERTATION RESEARCH**  
Credit to be arranged.

### **School of Nursing**

Barbara Logan, Director, School of Nursing

**Major**  
Nursing

**Degree**  
M.S.

Courses are offered in health to provide electives for students in other areas.

The objectives of the Master of Science degree program with a major in nursing are to provide graduates with the ability to:

1. integrate advanced knowledge from nursing and related disciplines into a specialized area of nursing practice and a functional role;
2. evaluate and apply research findings from nursing and related disciplines to advanced nursing practice;
3. demonstrate competence in a selected functional role of educator, administrator or clinical specialist;
4. demonstrate competence in advanced nursing practice as family nurse practitioner;
5. participate in the development of nursing knowledge by identifying researchable nursing problems, conducting research and selectively integrating research findings in advanced nursing practice;
6. utilize leadership, management, and teaching knowledge and competency to influence nursing practice;
7. participate as a leader to influence health policy and improve the health care delivery system; and
8. contribute to the advancement of the nursing profession.

### **Admission Requirements**

In addition to meeting University admission requirements, applicants should be graduates of baccalaureate programs accredited by the National League for Nursing. Under unusual circumstances, this requirement may be waived by the director of the School of Nursing. The applicants must also be licensed to practice professional nursing in the state(s) in which they do their clinical practice and carry professional liability insurance. Opportunity to do clinical practice in sites outside the Clemson area and/or South Carolina is subject to availability of appropriate faculty.

### **The Program**

The Master of Science program with a major in nursing is designed to build upon the first professional degree. The student acquires knowledge and skills in advanced nursing practice and may select a nursing specialty and a role area or the practitioner emphasis. Areas of practice specialization are adult health, child health, gerontology and maternal-infant health. Role areas include education, management and clinical specialization. The practitioner emphasis is the family nurse practitioner. Upon graduation, students will be prepared for advanced practice in a designated area of nursing. Health assessment is a prerequisite to enrollment in the graduate program.

A thesis or nonthesis option is available. Normally, 37 semester credit hours are required for awarding the Master of Science degree; 43 semester credit hours are required for the family nurse practitioner emphasis with the nonthesis option, and 46 hours with the thesis option.

The master's program articulates with the baccalaureate program in the continued acquisition of advanced nursing knowledge and skills of the specialist. Using pervasive and progressive concepts and subconcepts, this specialization builds toward advanced nursing practice in selected clinical practice and role areas. Theory, research and role development are emphasized to enable the graduate to participate in the development of nursing knowledge and contribute to the advancement of the nursing profession.



- NURS 671 HOLISTIC APPROACHES TO HEALTH**  
3 cr. (3 and 0)
- NURS 801 ADVANCED FAMILY NURSING**  
3 cr. (3 and 0)  
Developmental, psychodynamic, social-political, and cultural theories and concepts synthesized and applied to the analysis of health and illness in families across the life cycle; roles and functions of advanced practice nurses in promoting family health.
- NURS 802 ADVANCED LEADERSHIP AND ROLE**  
3 cr. (3 and 0)  
Introduction to the advanced roles of educator, administrator and clinical specialist in nursing; leadership theory/models and practices; leadership functions of program planning and evaluation, and health policy formation.
- NURS 804 KNOWLEDGE DEVELOPMENT IN ADVANCED NURSING**  
2 cr. (2 and 0)  
Nursing theories and theories relevant to nursing practice and research; processes of theoretical thinking and critical thinking applied to health problems and needs of individuals and their families in the community; theoretical and conceptual models of contemporary practice and research.
- NURS 805 PHARMACOTHERAPEUTICS FOR ADVANCED NURSING**  
3 cr. (3 and 0)  
Prescription, administration and patient/family education in use of pharmacological agents, emphasizing the drugs prescribed for common or chronic illnesses, particularly drug selection, adverse drug reactions, age-related differences in utilization and regulations affecting nurse's prescriptive authority. **Prerequisite or Corequisite:** NURS 809.
- NURS 806 ADVANCED ASSESSMENT FOR NURSING**  
2 cr. (1 and 3)  
Comprehensive assessment and diagnosis of health problems and status for individuals of all ages, including assessment of families; physical and laboratory/radiologic diagnostic assessments; directed laboratory experiences in advanced assessment of clients of several ages. **Prerequisites or Corequisites:** NURS 801 and 809.
- NURS 807 CLINICAL NURSING RESEARCH**  
2 cr. (2 and 0)  
Quantitative and qualitative research methodologies useful and appropriate to clinical nursing practice and for the development of nursing knowledge; ethics with human subjects; does not include thesis advisement.
- NURS 808 NURSING RESEARCH ANALYSIS**  
2 cr. (2 and 0)  
Quantitative research methods in nursing science, including basic elements of statistical design with a focus on the use of nursing informatics and computer applications. **Prerequisite:** Undergraduate statistics course.
- NURS 809 PATHOPHYSIOLOGY FOR ADVANCED NURSING**  
2 cr. (2 and 0)  
Human response to health problems and illness from the nursing perspective, focusing on the conceptual approach to pathophysiologic phenomena.
- NURS 811 ADVANCED NURSING AND HEALTH POLICY**  
2 cr. (1 and 3)  
Reciprocal influence of nursing, client health and policy making on the delivery of health care; laboratory experience incorporates a variety of directed activities related to the policy process. **Prerequisites:** NURS 801, 805 and 809.
- NURS 812 THE DYNAMICS OF COMMUNITY HEALTH**  
3 cr. (3 and 0)  
Relation of family health to community; epidemiological appraisal of community health; significance of process in planning and decision making; values guiding use and availability of health resources.
- NURS 819 FAMILY NURSING I: DEVELOPING FAMILIES**  
4 cr. (2 and 6)  
Theories and concepts related to nursing management in the care of developing families; critical thinking applied to health problems and needs of developing families before, during and immediately following pregnancy; application of related nursing issues and current research; clinical practice with developing families in a variety of settings. **Prerequisites:** NURS 801, 805, 806 and 809.
- NURS 820 FAMILY NURSING II: CHILD AND ADOLESCENT**  
4 cr. (2 and 6)  
Advanced nursing roles and functions applied to health promotion, health maintenance, health restoration, habilitation and rehabilitation of infants, children and adolescents with existing or potential health problems; critical thinking used to assess, diagnose, intervene and promote continuity of care with clients of these ages irrespective of setting. **Prerequisites:** NURS 801, 805, 806 and 809.
- NURS 821 FAMILY NURSING III: ADULT**  
4 cr. (2 and 6)  
Roles and functions embodied in advanced practice applied to the health promotion and clinical management of common or chronic health problems of adults within the context of family; clinical practice with adult clients occurs in a variety of settings. **Prerequisites:** NURS 801, 805, 806 and 809.
- NURS 822 FAMILY NURSING IV: GERONTOLOGY**  
4 cr. (2 and 6)  
Roles and functions of advanced practice applied to the preventive, restorative and rehabilitative care of the older adult with existing or potential health problems; clinical practice in a variety of settings. **Prerequisites:** NURS 801, 805, 806 and 809.



- NURS 823 PRACTICUM IN ADVANCED FAMILY NURSING**  
6 cr. (0 and 18)  
Guided practice applying advanced nursing knowledge in family nursing and advanced practice roles (clinical nurse specialist, case manager and/or practitioner); joint preceptor and faculty guidance and supervision in the care of selected populations in a variety of health care settings. **Prerequisites:** NURS 819, 820, 821 and 822.
- NURS 825 THEORIES AND MODELS OF NURSING ADMINISTRATION**  
3 cr. (3 and 0)  
Identification, analysis and synthesis of theories, models and issues related to nursing management and leadership; organization, attitudes and practices applicable to the middle and executive levels of nursing administration. **Prerequisite:** NURS 835, 837, 840 or 861.
- NURS 826 ADMINISTRATION OF NURSING SERVICES**  
3 cr. (2 and 3)  
Application of theories and models to specific nursing administration issues and problems; practicum in nursing administration at the middle or executive level permits specific use and evaluation of a conceptual model of nursing administration. **Prerequisite:** NURS 825. **Corequisite:** NURS 836, 838, 841 or 862.
- NURS 827 FOUNDATIONS OF NURSING EDUCATION**  
3 cr. (3 and 0)  
Exploration of the foundations of nursing education with emphasis on curriculum development in nursing; current issues and research which influence nursing education. **Prerequisite:** NURS 835, 837, 840 or 861.
- NURS 828 THE NURSE EDUCATOR**  
3 cr. (2 and 3)  
Continuation of NURS 827; major focus on teaching in nursing education programs; course development and selection of learning experiences; current issues and research in classroom and clinical teaching; a teaching practicum is required. **Prerequisite:** NURS 827. **Corequisite:** NURS 836, 838, 841 or 862.
- NURS 829 THEORIES AND MODELS OF CLINICAL SPECIALIZATION**  
3 cr. (3 and 0)  
The caregiver, researcher, manager, teacher and consultant roles of the clinical nurse specialist in a variety of settings; theories, models and health care issues underlying the role of clinical nurse specialist. **Prerequisite:** NURS 835, 837, 840 or 861.
- NURS 830 CLINICAL SPECIALTY PRACTICUM IN NURSING**  
3 cr. (1 and 6)  
Advanced practice in a selected clinical specialty area in nursing that emphasizes application of the clinical specialist role. **Prerequisite:** NURS 829.
- NURS 831 CLINICAL PROBLEMS IN ADVANCED NURSING**  
1-3 cr. (1-3 and 0)  
Critical thinking and knowledge of methodologies for scientific inquiry applied to clinical issues/problems encountered in advanced nursing practice. May be repeated for a maximum of three credits. **Prerequisites:** NURS 804, 807 and 808. **Corequisites:** NURS 819, 820, 821 and 822.
- NURS 833 REHABILITATIVE NURSING I**  
6 cr. (3 and 9)  
Advanced concepts, principles and theories basic to humanistic practice of professional rehabilitative nursing; repatterning as an integral part of the human development process; clinical laboratory experience selected from rehabilitation, ambulatory and community settings. **Prerequisites:** NURS 801, 804, 807 and 812.
- NURS 835 ADVANCED NURSING OF DEVELOPING CHILDREN**  
5 cr. (3 and 6)  
Analysis of physiological, psychological, sociocultural, developmental and family theories, issues and research that form the basis for nursing practice with families who have healthy children within the developmental levels of birth through adolescence; interventions related to achieving and maintaining optimal health, growth and development incorporated into advanced clinical practice. **Prerequisites or Corequisites:** NURS 802, 804 and 807.
- NURS 836 ADVANCED NURSING OF CHILDREN WITH HEALTH DEFICITS**  
5 cr. (3 and 6)  
Effects of health deficits, separation and hospitalization on children and their families; nursing concerns, issues, management and research related to ill or disabled children; adjudication of expanding nursing roles incorporated into advanced clinical practice. **Prerequisite:** NURS 835.
- NURS 837 ADVANCED NURSING OF CHILDBEARING FAMILIES**  
5 cr. (3 and 6)  
Theories and advanced concepts related to nursing management in the care of healthy childbearing families; major physiological, psychological and sociological changes related to antepartum, intrapartum, postpartum and neonate, incorporated into advanced clinical practice; related nursing issues and current research. **Prerequisites or Corequisites:** NURS 802, 804 and 807.
- NURS 838 ADVANCED NURSING OF CHILDBEARING FAMILIES AT RISK**  
5 cr. (3 and 6)  
Care of childbearing families at risk for complications in physical, socioenvironmental and psychological development; nursing concerns, issues, management and research related to care of the high-risk childbearing family, incorporated into advanced clinical practice. **Prerequisite:** NURS 837.



- NURS 840 ADVANCED GERONTOLOGICAL NURSING I**  
5 cr. (3 and 6)  
Critical, comprehensive overview of research, knowledge, concepts and issues basic to the advanced practice of nursing care of older adults; phenomenon of human aging as reflected by changes in elders' patterns of living; clinical experiences scheduled from a variety of health care settings. **Prerequisites or Corequisites:** NURS 802, 804 and 807.
- NURS 841 ADVANCED GERONTOLOGICAL NURSING II**  
5 cr. (3 and 6)  
Continuation of NURS 840; builds on the review of research on the phenomenon of aging; continues the investigation of theories relevant to nursing care of the older adult; clinical experiences scheduled from a variety of settings that provide health care for older adults. **Prerequisite:** NURS 840.
- NURS 850 INFORMATION AND CONTROL SYSTEMS FOR NURSING LEADERSHIP**  
3 cr. (3 and 0)  
Computer-based systems of information management and control for nursing environments; data needed for cost-efficient use of nursing resources and effective systems of monitoring, quality assurance and control, emphasizing information systems as tools useful to humanistic nursing practice, human resource management, and solution of professional and scientific problems. **Prerequisite:** Graduate standing.
- NURS 861 ADVANCED ADULT NURSING I**  
5 cr. (3 and 6)  
Theories and research related to physiological, psychological and sociocultural concepts that form the basis of advanced adult nursing practice; emphasis is on human responses to selected phenomena which influence the health status of adults; current issues and research influencing the practice of adult nursing. **Prerequisites or Corequisites:** NURS 802, 804 and 807.
- NURS 862 ADVANCED ADULT NURSING II**  
5 cr. (3 and 6)  
Continuation of the study of theories, research and concepts that form the basis of adult nursing practice; emphasis is on factors influencing wellness and illness in the care of adults; related issues and current research. **Prerequisite:** NURS 861.
- NURS 879 SPECIAL TOPICS IN NURSING**  
1-3 cr. (1-3 and 0-9)  
In-depth seminar on selected topics, such as therapeutic communication, legal and ethical issues in nursing, and health care and political process in health. **Prerequisite:** Permission of instructor.
- NURS 881 GRADUATE PROJECT**  
Credit to be arranged.  
Scholarly experience enhancing the student's professional goals with significance for nursing practice, education or administration; the project nature is flexible and is negotiated between the student and graduate committee. Minimum of three credit hours required for students selecting the nonthesis option. **Prerequisite:** Negotiated between student and committee.
- NURS 889 SPECIAL PROBLEMS IN NURSING**  
1-6 cr. (1-6 and 0)  
Problems selected to meet special and individualized interests of students. Up to six hours of NURS 889 may be taken as elective credit. **Prerequisites:** NURS 801, 804, 807 and permission of instructor.
- NURS 891 MASTER'S THESIS RESEARCH**  
Credit to be arranged.  
Research activities related to thesis; minimum of six hours required. **Prerequisites:** NURS 802, 804 and 807.
- HLTH 600 SELECTED TOPICS IN HEALTH**  
1-6 cr. (1-6 and 0)
- HLTH 601 HEALTH CARE CONSUMERISM**  
3 cr. (3 and 0)
- HLTH 602 PRINCIPLES OF HEALTH FITNESS**  
3 cr. (3 and 0)
- HLTH 610 CONCEPTS OF CHILD HEALTH**  
3 cr. (3 and 0)
- HLTH 611 HEALTH NEEDS OF HIGH RISK CHILDREN**  
3 cr. (3 and 0)
- HLTH 615 PUBLIC HEALTH ISSUES IN OBESITY AND EATING DISORDERS**  
3 cr. (3 and 0)
- HLTH 620 HEALTH PROMOTION AND WELLNESS INTERNSHIP**  
1-6 cr. (0 and 3-18)
- HLTH 630 HEALTH PROMOTION OF THE AGED**  
3 cr. (3 and 0)
- HLTH 631 PUBLIC AND ENVIRONMENTAL HEALTH**  
3 cr. (3 and 0)
- HLTH 650 APPLIED HEALTH STRATEGIES**  
4 cr. (3 and 3)
- HLTH 698 CONTEMPORARY HEALTH PROBLEMS**  
3 cr. (3 and 0)
- HLTH 809 EPIDEMIOLOGICAL RESEARCH (MICRO 809)**  
3 cr. (3 and 0)



## INDEX

- Academic Common Market, 23
- Academic Dishonesty Policy, 30
- Academic Expenses, 19, 20
- Academic Records, Permanent, 27
- Academic Regulations, 27
- Academic Renewal, 25
- Academic Requirements, 12, 24
  - Change of Degree, 24
  - Conditional Acceptance, 24
  - Doctoral Degrees, 24
  - International Students, 11, 24
  - Master's Degrees, 24
  - New Applicants, 24
  - Presently Enrolled, 24
  - Professional Degrees, 24
  - Readmission, 25
- Academic Research, 31
- Academic Standards (Grading), 28
- Academic Work, Assessment of Previous, 24
- Accounting, 86
- Accounts, Past Due, 21
- Administration
  - Graduate School, 8
  - University, 8
- Administration and Supervision, 150
- Admission Classifications, 25
  - As a Nondegree Student, 25
  - As a Postbaccalaureate Student, 25
  - To a Degree Program, 25
- Admission Procedures and Requirements, 23
  - Academic Renewal, 25
  - Change of Degree, 24
  - Conditional Acceptance, 24
  - New Applicants, 24
  - Presently Enrolled in the Graduate School, 24
  - Readmission, 25
- Admission to Candidacy for Degree, 27
- Admission to a Degree Program, 25
- Advisor, Major, 27
- Advisory Committee, 27
- Agricultural and Applied Economics, 62
- Agricultural Education, 65
- Agricultural Engineering, 66, 125
- Agricultural Mechanization, 66
- Agriculture, 66
- Agriculture and Forestry Research System, 10
- Agriculture, Forestry and Life Sciences, College of, 42
- Agronomy, 53
- Animal, Dairy and Veterinary Sciences, 42
- Animal and Food Industries, 42
- Animal Physiology, 43
- Appeals and Grievances, 29
- Application
  - Deadlines, 11, 23
  - Fees, 12, 24
  - For a Diploma, 27
  - Materials, 24
  - Time Limit, 12, 24
- Applied Economics, 67, 87
- Applied Psychology, 102
- Applied Sociology, 98
- Appointments, Graduate, 21
- Aquaculture, Fisheries and Wildlife Biology, 59
- Architecture, 72
- Architecture, Arts and Humanities, College of, 72
- Art and Architectural History, 79
- Assistantships
  - Appointment Process, 22
  - Departmental Graduate, 21
  - Graduate Resident, 22
  - Termination of, 22
- Astronomy, 147
- Athletic Tickets, 20
- Auditing, 20, 29
- Awarding of Graduate Degree Posthumously, 27
- Biochemistry, 45
- Bioengineering, 106
- Biological Sciences, 46
- Biology, 47
- Board of Trustees, 8
- Botany, 47
- Business Administration, 87
- Business and Public Affairs, College of, 86
- Calendar, Clemson University, 2
- Candidacy for a Graduate Degree, 27
- Career Center, 12
- Ceramic Engineering, 108
- Certification, Teacher, 26
- Change of Degree Program, 24
- Checklist on Graduate School Procedures, 3
- Chemical Engineering, 109
- Chemistry, 126
- City and Regional Planning, 74
- Civil Engineering, 128
- Clemson University, 7
- Coaching Education, 158
- Communication, Professional, 84
- Community and Rural Development, 64
- Comprehensive Examination before Admission
  - to Ph.D. Candidacy, 37
- Computer Engineering, 131
- Computer Science, 133
- Computing Facilities, DCIT Policy on Misuse of, 10
- Concert Tickets, 20
- Conditional Acceptance, 24
- Construction Science and Management, 76
- Continuous Enrollment, 28
- Copyrights and Patents, 35
- Correspondence Directory, inside back cover
- Counseling and Guidance Services, 150
- Course Listings, Explanation, 38
- Course Offerings, 38
- Course Prefixes, 38
- Course Work Required
  - Master's, 35
  - Ph.D., 36
- Courses, Special, 38
- Curriculum and Instruction, 155
- Dairy Sciences, 42
- DCIT Computing Facilities, 10
- Deadline Dates, 3, 11, 23



- Deans and Executive Officers, 8
- Degree Requirements, 35
  - Doctor of Education, 38
  - Doctor of Philosophy, 36
  - Master's Degree, 35
  - Specialist in Education, 36
- Departmental Graduate Assistantships, 21
- Diploma, Application for, 27
- Directory for Correspondence, inside back cover
- Disabilities, Students with, 14
- Dishonesty, Academic, Policy on, 30
- Dissertations (Also see Theses and Dissertations), 34
- Doctor of Education Degree, 38
- Doctor of Philosophy Degree, 36
- Duplication of Higher Degrees, 25
  
- Earth Sciences (See Hydrogeology), 115
- Economics, 91
- Economics, Applied, 67, 87
- Education Courses, 150
- Educational Administration and Supervision, 148
- Educational Leadership, 150
  - Courses in, 152
- Electrical Engineering, 136
- Electron Microscope Facility, 9
- Electronic and Photographic Services, 10
- Elementary Education, 150
- Employees' Eligibility for Graduate Study, 26
- Employment
  - Hourly, 23
  - International Students, 11, 24
  - Restrictions, 23
  - Student, 21
- Engineering and Science, College of, 106
- Engineering Graphics, 117
- Engineering Mechanics, 117
- English, 79
- Enrollment
  - Auditing, 29
  - Clemson University Seniors, 26
  - Continuous, 28
  - In Graduate Courses, 26
  - Limit, 29
  - Minimum, 22
  - Opportunities, 7
  - Pass/Fail Basis, 29
  - Restrictions, 26
  - Teacher Certification or Recertification, 26
  - Transient Graduate Students, 26
  - University Employees, 26
- Entomology, 54
- Environmental Science, 112
- Environmental Systems Engineering, 113
- Environmental Toxicology, 67, 115
- Equal Opportunity Statement, inside front cover
- Examinations, Comprehensive before Admission to Candidacy, 37
- Examinations, Final, 28
  - Master's, 36
  - Ph.D., 38
- Executive Officers and Deans, 8
- Expenses, 12, 20
- Experimental Statistics, Department of, 55
  
- Family/Faculty Housing, 14
- Fees
  - Academic, 12, 19
  - Application, 11, 24
  - Athletic Tickets, 20
  - Auditing, 20
  - Concert Tickets, 20
  - Establishment of, 21
  - Faculty and Staff, 21
  - Graduate Assistants, 22
  - Graduate Fellows and Trainees, 22
  - Graduate Students, 19
  - Graduation, 20
  - Health Care, 12, 13, 20
  - International Students, 11, 12
  - Medical, 12, 13, 20
  - Off-campus, 19
  - Out-of-country, 19
  - Postbaccalaureate Students, 19
  - Refund of, 21
  - Settlement of, 20
  - Vehicle Registration, 20
- Fellowships, 22
- Filing Graduate Degree Curriculum, 27
- Final Doctoral Oral Examination, 38
- Final Examination
  - Courses, 28
  - Master's, 36
  - Ph.D., 38
- Finance, 94
- Financial Aid Office, 23
- Financial Assistance, 12, 21, 23
- Fiscal Policy, 20
- Fisheries Biology, 59
- Food Science, 69
- Food Service, 13
- Food Technology, 70
- Foreign Language Requirement
  - Master's, 35
  - Ph.D., 37
- Forest Resources, 60
  
- Genetics, 48
- Geography, 83
- Geology (See Hydrogeology), 115
- Governance, University, 8
- Grade Protests, 31
- Grading, 28
- Graduate Appointments, 21
- Graduate Assistantships, 21
- Graduate Curriculum Committee, 9
- Graduate Degree Curriculum, Filing of, 27
- Graduate Expenses, 12, 19
- Graduate Programs and Course Offerings, 38
- Graduate Resident Assistantships, 22
- Graduate School, 9
  - Administration, 8
  - Regulations, 26
- Graduate Student Government, 9
- Graduate Studies Courses, 38
- Graduation Fees, 20
- Graphic Communications, 94
- Grievances and Appeals, 29



- GS 799, 29, 38  
 Guidance Services, 150
- Handicapped Students (see Disabilities, Students with), 14  
 Health, 172  
 Health (Public), 164  
 Health, Education and Human Development, College of, 150  
 Health Services, 13  
 History, 82  
 Horticulture, 56  
 Hospital Administration, 97  
 Housing, 13  
   Apartments, 14  
   Family/Faculty, 14  
   Graduate Student, 14  
   Graduate and Undergraduate Student, 13  
   International Students and Exchange Visitors, 14  
   Residence Halls, 14  
 Human Resource Development, 165  
 Hydrogeology, 115
- Incomplete Graduate Course Work, 28  
 Independence of Graduate Degrees, 29  
 Industrial Education, 167  
 Industrial Engineering, 118  
 Industrial Management, 94  
 Integrated Pest Management, 67  
 International Programs and Services, 11  
 International Students and Exchange Visitors, 11, 12, 14
- Language Requirement (See Foreign Language Requirement)  
 Languages, 84  
 Law, 87  
 Libraries, Clemson University, 11  
 Loans, 23
- Major Advisor, 27  
 Management, Industrial, 94  
 Management Science, 97, 140  
 Marketing, 98  
 Master's Degree, 35  
 Materials Science and Engineering, 111  
 Mathematical Sciences, 140  
 Mechanical Engineering, 120  
 Medical Requirements, 13, 25  
 Microbiology, 49  
 Minor, 27, 35, 36  
 Misrepresentation, Penalties for, 14
- Nondegree Student, 25  
 Nursing, School of, 169  
 Nutrition, 50
- Oak Ridge Associated Universities, 9  
 Off-campus Research  
   Master's, 36  
   Ph.D., 37  
 Opportunities, Enrollment, 7  
 Opportunity, Equal, inside front cover  
 Organization of this Publication, 3
- Parks, Recreation and Tourism Management, 162  
 Past Due Accounts, 21  
 Patents and Copyrights, 35  
 Performing Arts, 78  
 Permanent Academic Records, 27  
 Philosophy and Religion, 84  
 Physics, 146  
 Plant Pathology, 57  
 Plant Physiology, 58  
 Political Science, 100  
 Postbaccalaureate Student, 25  
 Poultry Science, 51  
 Procedures  
   Admission, 23  
   Pursuing a Degree, 26  
 Professional Communication, 84  
 Psychology, 102  
 Public Administration, 100  
 Public Health, 164  
 Publication Policy, Theses and Dissertations, 34  
 Purpose of Catalog, inside front cover
- Reading, 155, 156  
 Readmission, 25  
 Refund of Fees, 21  
 Regulations  
   Academic, 27  
   General Graduate School, 26  
 Religion and Philosophy, 84  
 Requirements  
   Academic, 24  
   Admission, 23  
   Degree, 35  
   Doctor of Education, 38  
   Doctor of Philosophy, 36  
   Domicile, 14  
   Master's, 35  
   Medical, 13, 25  
   Specialist in Education, 36  
   Visa, 12  
 Research  
   Academic, 31  
   Facilities, 9  
   Off-campus, 36, 37  
   Resources, 9  
   Scientific, 35  
   Theses and Dissertations, 34  
 Residence Halls, 14  
 Residence Requirements, 14  
   For in-State Fees, 19  
   Master's, 35  
   Ph.D., 36  
 Residency Law, South Carolina, 15  
 Resident Assistantships, 22  
 Resident Status  
   Application for, 14  
   Requirements, 15  
 Restrictions  
   Enrollment, 26  
   Special Employment, 23  
   Use of Theses and Dissertations, 34  
 Returned Checks/Charge Cards Policy, 20  
 Rural Sociology, 99



Scientific Research, 35  
 Secondary Education, 155  
 Seniors, Enrollment in Graduate Courses, 26  
 Settlement of University Fees, 20  
 Sexual Harassment, Policy on, 31  
 Sociology  
     Applied, 98  
     Rural, 99  
 South Carolina Agriculture and Forestry Research System, 10  
 Special Courses, 38  
 Special Education, 150  
 Specialist in Education Degree, 36, 150  
 Speech, 82  
 Sponsored Programs Office, 9  
 Student Employment, 12, 21, 23  
 Student Financial Aid Office, 23  
 Student Responsibility, inside front cover  
 Student Services, 12  
 Students  
     International, 11  
     Off-campus, 7  
     On-campus, 7  
     With Disabilities, 14  
 Supervision, Educational, 150  
  
 Teacher Certification or Recertification, 26  
 Technical Education, 168  
 Telecampus, 7  
 Textile and Polymer Science, 123  
 Textile Chemistry, 123  
 Textile Science, 124  
 Theses and Dissertations, 34  
     Abstract, 20  
     Binding Fee, 21, 34  
     Faculty Responsibility, 34  
     Patents and Copyrights, 35  
     Publication Policy, 34  
     Restrictions on Use of, 34  
     Scientific Research, 35  
     Student Responsibility, 34

## Tickets

Athletic, 20  
 Concert, 20

## Time Limit

Application, 11, 12, 24  
 Master's, 35  
 Ph.D., 36

## Traineeships, 22

## Transfer Credit, Acceptance of, 29

## Transient Graduate Students, 26

## Tuition (See Fees, Academic), 12, 19

## University Employees

Enrollment, 26  
 Fees, 19

## University Governance and Administration, 8

## Vehicle Registration, 20

## Veterinary Sciences, 42

## Visa Requirements, 12

## Visitors, International Exchange, 11, 12, 14

## Visitors Center, 7

## Visual Arts, 78

## Vocational/Technical Education, 168

## Wildlife Biology, 59

## Withdrawal from Courses, 28

## Zoology, 52



## DIRECTORY FOR CORRESPONDENCE

### Mailing Address

Clemson University, Clemson, SC 29634

### University Switchboard

(864) 656-3311

### Affirmative Action

Office of Access and Equity, E-103 Martin Hall,  
telephone (864) 656-3181, zip: 29634-5004

### Assistantships

Address the chair of the department of proposed major.

### Financial Aid

Office of Student Financial Aid, G01 Sikes Hall,  
telephone (864) 656-2280, zip: 29634-5123

### Graduate Study

Graduate School Office, E-106 Martin Hall,  
telephone (864) 656-3195, zip: 29634-5120

### Housing

Housing Office, 200 Mell Hall, telephone (864) 656-2295, zip: 29634-4075

### International Programs and Services

Office of International Programs and Services,  
E-208 Martin Hall, telephone (864) 656-2457,  
zip: 29634-5120

### Public School Teachers Information

Agricultural Education, telephone (864) 656-3300,  
zip: 29634-0356  
Curriculum and Instruction (Elementary and Secondary  
Education), telephone (864) 656-5108,  
zip: 29634-0709  
Technology and Resource Development (Industrial  
Education), telephone (864) 656-3645,  
zip: 29634-0711  
Off-Campus Courses — Office of Extension and  
Public Relations, telephone (864) 656-2498,  
zip: 29634-0713

Clemson University



3 1604 011 861 756

### Registration and Class Schedules

Registrar, 102 Sikes Hall, telephone (864) 656-2171,  
zip: 29634-4019

### Telecampus

Director, E-205 Martin Hall, telephone (864) 656-4227  
or 1-800-922-8316 (within South Carolina), or 1-800-332-6406 (outside South Carolina), zip: 29634-5121

### Transcripts

Registrar, 104 Sikes Hall, telephone (864) 656-2173,  
zip: 29634-4019

### Veterans Affairs

Registrar, 102 Sikes Hall, telephone (864) 656-5280,  
zip: 29634-4019

The business and administrative offices of the University are open 8 a.m. to 4:30 p.m. Monday through Friday for 12 months of the year except for official University holidays.



**CLEMSON**  
UNIVERSITY

Clemson, South Carolina